THE

ELECTRICAL REVIEW.

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J. A. BERLY'S

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THE COST OF PRODUCING ELECTRICITY.

IN the last issue of our contemporary, *Lightning*, there appears an article by Mr. Crompton giving an analysis of the cost of producing electricity in 1891 in the central stations of 10 supply companies, viz.—the St. James's, Kensington, Metropolitan, House-to-House, Westminster, Chelsea, and London Electric in London, and the Newcastle-on-Tyne, Bradford, and Newcastle and District in the provinces. Taking the actual figures of total cost per unit sold, the provincial stations head the list, and are followed by the London ones, in both cases in the order in which they are named above; but Mr. Crompton very justly points out that with some of the items which go to make up this cost it is difficult to make any fair comparison, and he therefore devotes his remarks more especially to the items for fuel, stores, and wages, with a passing reference to the other items of management, rents, depreciation, repairs, &c. Even with fuel and wages the value of the analysis would be much enhanced, if it were accompanied by some information concerning the load diagrams, as the area and general character of these diagrams must naturally affect the expenditure on fuel and wages. For example, the fact that the St. James's Company occupies the position of a very good first amongst the London companies as to cost both of fuel and labour is certainly to be explained by the more favourable load diagrams obtained by this company.

The most noticeable conclusions derived from the figures quoted are, first, that when allowance is made for the different price and calorific value of the fuel used (an allowance which is made by increasing the item for coal at Bradford by 100 per cent. and at Newcastle by 185 per cent.), the low pressure companies come out well ahead of their high pressure rivals; the cost of the fuel and labour in the latter case being given as 81 per cent. more than in the former, when Bradford, St. James's, and Kensington are compared with Newcastle-on-Tyne, Metropolitan, and House-to-House. This figure of 81 per cent. should, we think, be 70 per cent., as there appears to be a slip in the calculation for increasing the cost of fuel at Newcastle, and the item debited to the same company for labour is greater than it should be; but, whichever figure is taken, there is still a very substantial difference in favour of the low pressure systems, to be used as a set-off against any gain in the matter of capital expenditure which may result from the use of high pressure. The items for labour do not show that difference in favour of low pressure systems with accumulators that has been claimed; as we find that the cost of labour to the Kensington, Metropolitan, and Chelsea Companies is practically identical, and that a similar equality occurs between the Westminster and House-to-House, and between the Newcastle Companies and St. James's. With regard to

the Newcastle-on-Tyne Company, the figure given by Mr. Crompton, viz., 1·10 pence per unit for labour is, as we stated previously, too great, as it includes a proportion of management expenses, and would be reduced to about ·75 penny by deducting this latter item.

Mr. Crompton concludes by holding out a hope that at some future time he may supplement these figures with others showing the comparative capital cost of the various systems, and such figures would undoubtedly be very useful; but for some time to come it will, we consider, be very difficult to arrive at a fair basis of comparison, as the various companies must be allowed time to get their plant and mains about equally employed.

SUB-STATIONS ELECTRIC SUPPLY.

AFTER all that has been written and said about the questions, Alternating *v.* Continuous Current Supply, there does not seem to be a decided tendency towards an agreement among electricians and engineers upon the continuance of the simple methods of electrical distribution represented by the simple low pressure continuous current systems, and the simple alternating current, high pressure, and transformer system.

In the beginning of the electrical supply movement, simple and well known methods and apparatus were adopted; the promoters and their advisers feeling on safe ground in laying out a supply system which was merely an enlarged copy of smaller isolated plants.

The alternating current systems first laid out were all planned to work on what has been called the house-to-house transformer system, with a network of high pressure supply feeders. The primitive ideas which controlled the adoption of these simple systems in some of the largest supply centres now in existence in England are gradually giving place to more highly developed ideas regarding what is required of a system of supply, and also regarding the most economical methods for meeting the requirements.

In large towns, the transmission of electrical energy from a station to distant points on low pressure direct supply entails heavy expenditure and great complications. With feeders to maintain the pressures, on the other hand, high pressure alternating currents in a network supplying from house-to-house is not desirable, nor is it practicable. The sub-station schemes have been brought forward as a solution of the difficulties in the way of extended supply from central stations. The principal idea in the sub-station schemes is to lay out one central generating station on a favourable site, where coal, water, and ashes can be readily handled in quantities, and then to connect various centres in the town or city with this main supply central station; the electrical energy being transmitted to these sub-centres or sub-stations at high pres sure, and there transformed and distributed at low pressure through a network of low pressure conductors. This idea is old, but only quite recently has it been urged as worthy of consideration.

The engineer, in proposing to adopt such a scheme, will find himself not a little embarrassed in choosing such a plan as may turn out the best; in fact, he may find it necessary to combine several systems in one scheme to enable him to derive all the benefits of a sub-station distribution.

It may be worth while here to shortly review the various sub-station schemes. Perhaps the oldest one proposed is that known as the battery system, with continuous currents. The generating central station on this plan is a high pressure continuous current station. The sub-stations store the electrical energy transmitted from the central station at high pressure, and then distribute at low pressure. This system has not yet made any progress practically. There are certain difficulties with high pressure continuous current dynamos working at over 2,000 volts or so, and the accumulators required at the sub-stations required to be charged in series and discharged in parallel—a complicated process—and they are exceedingly costly as transformers, both in first cost and in maintainance, and, as transformers, have not a specially high efficiency.

The next scheme we notice is the continuous current high pressure system, with dynamotor sub-stations. This scheme is open to the same objections as the first, on the score of the difficulties with high pressure dynamos and motors, but it would not cost so much for the sub-stations nor for maintainance as the battery stations. Both these systems may, and have been, worked on a small scale up to 1,000 volts, but it is doubtful if much higher pressures are practicable.

The first alternating current sub-station is that in use in London by The London Electric Supply Company. In this scheme the electrical energy is transmitted by high pressure alternating currents from one large generating station to several sub-stations where it is transformed and distributed at low pressure; in this scheme there is less trouble with high pressures in the dynamos, and there is no difficulty with the transformers at the sub-stations, neither are they so costly as either batteries or dynamotors. The transmission in this case has been worked at a pressure as high as 10,000 volts.

These three schemes may be looked upon as the first primitive types of sub-station distribution schemes; the idea seems good, it embraces high pressure for transmission of the energy and low pressure for the distribution; mark the difference between transmission and distribution, for it seems to dawn on us that transmission and distribution are different processes.

Now, batteries have advantages; continuous currents have advantages, and so have motor dynamotors if the high pressure motor part is an alternating motor. Can a sub-station scheme embrace them all? Several writers of late have mooted such a scheme that would enable us to use batteries, continuous currents, alternating currents and dynamotors all on one system. The idea is to employ high pressure multiphase currents for transmission of the energy from the generating stations to the sub-stations, at the sub-stations the multiphase currents are to be converted into low pressure continuous currents and low pressure alternating currents if desired. Batteries may there be used for storage, not as transformers. Dynamotors may there be used to convert the alternating currents into continuous currents, and it is also proposed to convert the multiphase currents into continuous currents by commutators. It would seem from this that the conclusion arrived at here is multiphase currents for transmission at high pressure to sub-stations and continuous currents at low pressure for distribution from sub-stations.

Multiphase currents for transmission are claimed to possess the advantages that they can efficiently be converted into continuous currents and can be used to work motors.

There can be little doubt about the future distribution schemes being something different from present practice. Increased demands for current over extended areas must inevitably bring the corporations undertaking the supply face to face with the limitations and difficulties in the way of extended supply on either the simple alternating or simple direct current supplies now in vogue. They may then turn to those proposals which just at present may appear to be rather impracticable and to savour of experimental schemes.

THE LONDON OVERHEAD WIRES ACT.

FROM the report, which we publish on another page, of the interview accorded to a deputation from the Electrical Trade Section of the London Chamber of Commerce by Sir Courtenay Boyle, it will be seen that the petition of the Chamber of Commerce, and the representations made to the Board of Trade by the Telephone Companies with regard to the proposed County Council bye-laws for the regulation of overhead wires, have met with a large measure of success; and that it is proposed by the Board of Trade that important modifications should be made in these bye-laws, which will remove, with one exception, practically all the restrictions which it was urged would press hardly on the industry, and hamper its development.

Of these, there is no doubt, in our opinion, that the most important is the proposed modification of Clause 8, which when amended will stipulate that the factor of safety for conductors and suspending wires shall be four instead of five, and that the maximum wind pressure to be allowed for shall be 30 lbs. instead of 50 lbs. per square foot. The amended clause will, we consider, provide very amply for the public safety; indeed, when it is remembered that the figures are to apply at a temperature of 22° Fahr., we think it may still be said to err rather on the side of excessive caution. The concession is, however, an important one, as owing to the large surface exposed by multiple telephone cables in comparison with their weight, the wind pressure to be allowed for is a very serious factor in the determination of the strains to which the line will be subjected. We hope that the success which has been attained in the present instance may be taken as a good omen; and that it may be the forerunner of a similar modification in the rules drawn up by the Board of Trade for the regulation of overhead electric light and power wires.

Modifications, though of less importance, have also been made in the other clauses relating to the structural details of the line; and a compromise, which we think should be satisfactory to all parties, has been arrived at with regard to the clauses which relate to plans and notices, as it will now be stipulated that particulars shall be given of the material and gauge of the wires, nature and position of the supports, and lengths of spans; and that a plan shall be deposited, or that these details shall be marked on a plan to be kept at the office of the Council; and, further, that the time for delivery of the plans and particulars of existing lines shall be extended from three to six months, and that, as regards future lines, the particulars must be given within a month after their erection, instead of a fortnight before the work is commenced.

The one exception to the success of the representations made is in the matter of inspection; as the clause relating to it, although it has been amended so as to require that reasonable notice of a proposed inspection shall be given by the Council, remains at present otherwise unaltered. We understand that the Committee of the Electrical Trades Section intends to make another effort to get the clause modified, as many of those interested in the matter consider that it will be a great hindrance to the obtaining of way-leaves. General Webber and Mr. Garcke, speaking at the meeting of the Trade Section on Friday last, appeared to take a more hopeful view of the case; the first-named speaker pointing out that the conditions were very different for existing and future way-leaves, and that with regard to the former it should certainly rest with the Council to show how permission to inspect should be obtained; but he was sanguine that no very great difficulty should be experienced in obtaining new way-leaves with the introduction of a carefully-worded clause to allow of inspection. The matter is a very important one to both parties, as without the power of inspection the County Council is practically unable to assure itself that the regulations have been carried out; and this point has evidently had great weight with the Board of Trade, as Sir Courtenay Boyle informed the deputation that, after careful consideration, it had been decided that to leave out the principle of this clause would be to destroy the whole object and effect of the regulations.

Considering the difficulties which will have to be overcome in any further attempt to get this clause modified, we believe that a compromise, such as we suggested a few weeks back, should be aimed at; that is that, whilst recognising the principle as correct, every effort should be made to arrange for the inspections being periodical. By this means any possible inconvenience to the householder would be minimised, as the inspections could only be made at stated intervals; and it would then perhaps be possible to so word the clause in the way-leave agreement as to make it appear, as Mr. Garcke suggested, in the interest of the householder, who, we think, would not object to an occasional inspection by a local authority for the purpose of ascertaining that the poles or other supports on his house were in no way becoming a possible cause of damage to his property.

Brake Horse-Power.

AN interesting criticism on the value of brake measurements of horse power occurred in a recent number of the *Engineer*. A correspondent had been endeavouring to prove that the usual methods of measuring B.H.P. are all wrong. Without being able to go quite so far as the extent of these conclusions, we must nevertheless admit that there is, or may be in certain cases, an "unconsidered element" which vitiates B.H.P. tests. The marked difference between the results obtained in practice and those which would be indicated by theory, are of such frequent recurrence that we cannot but believe that the accepted theory is erroneous or incomplete. Theory, in these matters, is apt to

be all too simple. In theorising we are prone to "neglect" this and "assume" that, to make our masses infinitely small and our cords infinitely thin, and to leave out of consideration all those quantities which cannot be put into our equations. The theory of tail rope brakes is deduced pretty much as follows:—An infinitely thin and perfectly flexible cord is invested with a mysterious property called μ; this cord is placed on a pulley with unequal weights hanging from its two ends, and the pulley is turned round against the greater weight. We then get out a formula for the power expended in overcoming the difference between the weights; and we call this power the B.H.P. The practice is somewhat different; we use a rope which is decidedly thick, and which is far from being perfectly flexible. What wonder, then, if our practice gives different results from our "theory." There is another element which is always neglected in brake measurement theory, it is the internal condition of the rope or blocks when the brake is in action. Theory assumes that the rope or wooden block is a static piece of apparatus, that it exerts a constant passive resistance to the motion of the pulley. This is not in agreement with practice. There are differences in the coefficient of friction at different parts of the pulley which cause the fibres of the rope or timber to slip to and fro on the pulley surface. Each fibre in contact with the pulley is in a perpetual state of agitation or vibration. At any instant some of the fibres are being dragged along with the pulley, while others are slipping back against the pulley, and still others may be at rest. The recoil of the fibres which are slipping back must, to a certain extent, deduct from the dragging effect of the others, and lessen the effective value of the greater weight. Thus, the difference of tensions at the ends of the cord is merely the *average* difference over a long period of time and over the whole length of the cord, and takes no account of those rapidly varying and imperfectly elastic changes of tension which are going on in every part of the cord which touches the pulley, during the whole time the pulley is in motion. Thus the H.P. measured by the brake is merely the difference between the total B.H.P. and the H.P. which is expended in internally damaging and heating the rope or blocks; it is, in fact, the power expended in overcoming *external* friction, and takes no account of the *internal*. To remedy this defect a coefficient should be determined for each material used, whether rope or timber, and for each velocity and pressure at which it is run on the pulley face. A set of such coefficients would be a useful addition to engineering data.

Storage Battery Traction.

MR. SALOM recently read before the Franklin Institute a paper on the present status of the storage battery system of street railway propulsion, and summarised the subject as follows:—First, why is it that no commercial results have been yet achieved in this promising field of electrical engineering? Secondly, what definite knowledge has been gained by the combined experience of the past few years? And, thirdly, what are the prospects of the storage battery system? We can answer these three queries in a very few words, and regret that the matter is so easily settled. First, because no secondary battery in the market at the present has been able to withstand tramcar work. Second, but little real knowledge except ability to give an answer to the first question. Third, the future entirely depends on the invention of a more reliable and less weighty accumulator. We agree with Mr. Salom that if as much money and engineering ability were spent on storage traction work as have already been devoted to the trolley system, results might be different. But the main obstacle is the secondary cells, and there seems to be little hope until the existing patent rights have expired and scope is given for free and independent research. That the self-contained car will ultimately supersede all others we have no doubt; but the accumulator to render this possible has not yet had a trial. Perhaps Mr. Epstein can solve the problem?

Nothing new under the Sun.

THE unearthing of forgotten work, though too often done for the purpose of disparaging the researches of modern physicists, and which is done in the spirit of not allowing a person the credit of original work, if it can be possibly proved that someone else has anticipated him, brings to light much that is of historical interest. In an article in the *Electrical Review* of New York, Mr. P. H. Van der Weyde gives an extract from "Philosophy of Renatus des Cartes," published in Amsterdam in 1690, in which magnetic lines of force, as shown by means of iron filings, are described and illustrated. Des Cartes calls them *lines of attraction*, and says that the filings become arranged in an order which shows sufficiently that there is around this body a kind of vortex, or rather an atmosphere of a very subtle matter, *because it passes* through the pores of the glass; it extends from one pole of the magnet to the other, and arranges itself so as to form arcs of circles, which appear to proceed from one pole A, to enter again into the magnet through the other pole B. Des Cartes also gives illustrations of the earth's magnetism, showing the increased inclination or dip of the compass needle at high latitudes, and also illustrates the hypothesis that the theory of magnetic and electric action involves rotary motion of the molecules, and of the ether surrounding them, and this in opposite directions, as shown by the right hand and left hand windings of the lines on the particles.

In Favour of Aluminium.

ALUMINIUM is so intimately associated with electrical enterprise that the following particulars will be read with interest by those who are noting the steady advance of this metal into popular favour. The Munich Research Station has been engaged for some months, at the instance of the Swiss Aluminium Aktien Company, in testing the suitability of aluminium for vessels to hold wort and beer. It appears that beer of the Bavarian type brewed with pure yeast keeps perfectly sound for a length of time in aluminium pocket flasks, both at a moderately high temperature, *e.g.*, 12° C. (54° Fahr.) and at a lower temperature, *e.g.*, 5° C. (41° Fahr.). The amount of aluminium which dissolved in beer that was kept for three weeks in a cellar at a temperature of 10° to 12° C. (50°—54° Fahr.) was quite inappreciable. The largest proportion found after repeated trials was only $\frac{8}{10}$ths of a milligramme per 100 cc. Experiments on fermenting wort in aluminium vessels, both at low temperatures and at temperatures above 20° C. (68° Fahr.) showed that the flavour of the liquid remained unchanged; the amount of metal dissolved was exceedingly small and as a material both for fermenting vessels and for the storage and transport of beer was thus held to be established. A special inquiry was instituted as to the suitability of aluminium for beer engines as compared with zinc and copper, an engine made of aluminium being fitted up and subjected to trial. Beer left for a long time in the pipes acquired no disagreeable taste or injurious properties as it does when the engines are made of the other metals commonly used. Even after protracted use the aluminium pipes remained perfectly bright and clear. These experiments, which were made under conditions likely to exist in actual practice, seem to indicate an important and hitherto unlooked for outlet for "the coming metal," and provide new arguments of a sanitary nature in favour of its extensive application.

THE POSITION AND PROSPECTS OF THE ALUMINIUM INDUSTRY.

THE mysterious halo which has since its discovery surrounded this interesting metal is fast now being dissipated and before long we may hope to be in a position to estimate clearly what the scope of its future is likely to be.

During the last two years, the methods of electric reduction worked out by Hall in America, and Heroult in France, have distanced all others. They are much alike in character and consist in the dissociation of aluminium, $Al_2 O_3$, dissolved in a molten bath of the fluorides of aluminium and sodium, by means of an electric current. Of the Heroult process but few exact particulars of its later working have been published, but from what is known of it the details are so similar to that of Hall that in most respects both can be treated from the same standpoint. Fortunately the Hall process has found an able and conscientious exponent in Mr. Alfred E. Hunt, the President of the Pittsburg Reduction Company, and to the papers of this gentleman, especially to one lately read before the Franklin Institute at Philadelphia, we are indebted for much valuable information.

Since the electric processes of reduction have superseded all others, it becomes important to enquire what these processes can do in the way of reducing the metal and how far they are capable of improvement, or are open to modification.

For the Hall and Heroult processes there are two fundamental requisites, pure alumina and a certain quantity of electric energy per lb. to reduce it. Now there is a general idea that the great item of cost is the reduction itself, and that because alumina is so abundantly distributed in clay and elsewhere, that therefore the raw material for the production of aluminium costs next to nothing, but this is not altogether correct. It has been found essential, if aluminium is to exhibit its most valuable properties, that it should be pure, or at least of 99 per cent. purity. To attain this, pure materials, particularly pure alumina free from iron and silicon, must be used. In England at the present time such anhydrous alumina costs 3d. per lb., and as 50 per cent. of aluminium can be extracted from it we have a cost for "ore" of 6d. per lb. for the metal reduced. This alumina is usually prepared from bauxite, a natural hydrated oxide, which is found in France and other places in very large quantities and which itself can be procured at a low rate. It is reasonable to assume, however, that as pure alumina is required in increasing quantities it will be prepared at a cheaper rate, and Mr. Hunt in a recent estimate anticipates that the cost can be brought down to 3d. per lb., for the metal contained, for large quantities.

The next point to be dealt with is the amount of current needed to reduce this alumina. In the Hall process this is found to be 20 E.H.P. hours per lb. of metal reduced, that is as nearly as possible 24 indicated H.P. hours per lb. of metal. This expenditure Mr. Hunt thinks it will in the future be possible to reduce by 25 per cent., but taking it as it is we have 24 I.H.P. hours at say 2 lbs. coal per hour required, or 48 lbs. coal, say, including waste, ½ cwt. per lb. of metal. This will admit of small coal being used which, in England, near coal fields, could be purchased for less than 6s. 8d. per ton delivered, or at the rate of 4d. per cwt. An expenditure of 2d. therefore for coal will reduce 1 lb. of aluminium.

Electrical engineers will hardly need to have it pointed out how economically a generating plant such as is here needed could be operated. The units may be large and they are required to work continuously at their full regular load night and day. The ordinary variations of the current being slight, both depreciation and attendance are at a minimum. If water power were employed the cost of generating the electricity would be still less. On a large scale and using water power, Mr. Hunt makes the following estimate of the cost of producing aluminium by the Hall process.

Alumina	3·0d.
Fluxes, carbons, &c...	1·5d.
Generating current...	3·0d.
Labour, superintendence	1·0d.
General expenses, interest, and repairs	1·0d.
Total	9·5d. per lb.

Mr. Hunt gives this as the conclusion to which he has arrived after carefully watching the Hall process for a year, and on the whole if all circumstances were favourable we are not prepared to dispute that aluminium could be produced at this cost, which bulk for bulk would make it little more than half the price of copper and much cheaper than brass. At this price it would compare directly with copper as an electric conductor, as for equal section its conductivity is about ·56 per cent. that of pure copper, and though its bulk would be nearly double, this would not be much of a drawback when bare strips were used, and in many cases would be more than compensated for by its superior lightness. While, however, the above may be considered the lowest possible price if the metal is reduced from alumina, M. Camille Faure has lately published particulars of a process by which he expects to produce aluminium at even cheaper rates.

It is based on the fact that electrolysis of aluminium chloride can be effected for about half the expenditure of energy necessary to reduce alumina. To obtain the chloride on a large scale, M. Faure proposes to employ a cupola capable of containing a charge of 20 to 30 tons of a mixture of carbon and bauxite made up in balls. A blast heated to 500 C. is passed through the furnace until the contents are thoroughly heated, then hydrochloric acid is passed in, after which air is again blown through, and then a further quantity of acid. For the quantities indicated above the process gives 10 tons of chloride in 24 hours, which passes off as a vapour and is condensed in metal cylinders at 200°. Silican chloride is formed at the same time, but its vapour can be separated from that of the aluminium chloride, as it condenses at a much greater heat.

Electrolysis is effected in large tanks heated exteriorly. Chlorine gas and some chlorides are given off, the latter are deposited and the former is led into closed chambers spread with lime, by which means chloride of lime is formed in the ordinary way. For this there is a sale as a by-product which would reduce the price of the aluminium manufactured.

For a production of 600 tons per annum and employing water power of 2,000 I.H.P., M. Faure estimates the cost of the generating plant at £40,000, on which he allows 10 per cent. for up-keep, interest and depreciation. The outlay on the electrical and chemical portion of the plant he also estimates at £40,000, on which 20 per cent. for up-keep, depreciation and interest is reckoned. His estimate of the cost of production then works out—

	Francs per kilo.
Motive power with interest and depreciation ...	·20
Factory costs, including interest and depreciation	·30
Bauxite at 30 francs per ton	·10
Coal	·65
Hydrochloric acid, 6 kilos at 50 francs, 1,000 kilos	·30
Labour and general expenses	·60
Total	2·15

Or about 10d. per lb.

Besides this, M. Faure reckons on producing about 12 kilos of chloride of lime per kilo of aluminium, which, if sold at current rates, would realise 1·80 francs, thus reducing the price of the aluminium to ·35 franc per kilo, or about 1½d. per lb.

It will be seen that not counting the by-product, the estimated cost by M. Faure's process is as nearly as possible that of the Hall, as worked out by Mr. Hunt on a somewhat similar scale. The process is interesting as an alternative to reduction from alumina, but notwithstanding the prospect of obtaining a valuable by-product, it is certain that great difficulties would arise in dealing with the chlorine which would make the work throughout unhealthy and troublesome as contrasted with the ease and simplicity of the Hall and Heroult processes. Although, therefore, we should be glad to hear of M. Faure's process being tried on a sufficiently large scale, there does not appear much prospect that it would greatly undercut the other electrolytic processes and we may therefore pretty safely conclude that the prospects of aluminium being placed on the market at anything under a shilling per lb. are very remote.

At present the nominal quotation is 2s. 6d. per lb. with a reduction for large quantities. At this price aluminium is bulk for bulk cheaper than tin, and therefore can be used in its place for making bronze without extra expense, and as

the aluminium bronzes are so much stronger than those containing tin, a considerable consumption is assured in this direction alone. The reduction of the price to 2s 6d. has so increased the demand that it is not probable the present quotation will recede much further until larger works are built, as on the scale on which the metal is manufactured now the demand will exceed the supply, while the overhead charges are so heavy in proportion to the output that anything under 2s. would hardly cover working expenses except at the works of the Aluminium Industry Company of Newhausen, which have water power and a productive capacity of about 1,000 lbs. of metal per diem.

This company has succeeded in paying a 3 per cent. dividend for the last financial year, during which the price of its metal has receded from 7s. to 2s. 6d. It has now we understand many orders on hand, and its success will certainly not only lead to extensions, but will create sufficient confidence to warrant capitalists in starting other works. At least another year must however pass before such works can have any effect on the market, and therefore it is pretty clear that present prices will be maintained for some time, after which it is probable that a rapid drop to about 1s. 6d. per pound will take place. Aluminium will then be as cheap as copper, bulk for bulk, and will displace it for many purposes.

In another article it is proposed to deal more fully with recent information on the qualities of the metal, and the purposes to which it can be applied.

WHAT ELECTRICIANS MEAN BY "EARTH."

By SYDNEY F. WALKER.

PERHAPS no science has a more puzzling nomenclature than electricity. Electrical engineers have named their units after the great men who have worked in their ranks, and by so doing have perpetuated the names of those men, as possibly nothing else could have done. But the names themselves, volts, ohms, amperes, farads, &c., are sad stumbling blocks to those who would like to know a little of the science, but who have not time to make a set study of it.

But of all terms used by electrical engineers, probably "earth" is the most puzzling.

Even the trained electrical engineer, the man who has spent a large portion of his life in the service of the science, has sometimes to think what is meant by "earth," in a particular case. How, then, can those who have not studied the subject follow its different meanings?

In the early days of electrical science, before we knew anything like as much of it as we do now, and when its use was confined almost entirely to experiments shown in the laboratory, we had not these difficulties.

In those days "earth" meant earth, and nothing else. Electricity being looked upon then as something very much like water, only that it flowed in wires instead of pipes, it was natural to refer to mother earth as the great natural reservoir of electricity, just as she was supposed to be of water; and the resemblance was a very close one. As is well known, you can always procure water if you dig down far enough in the earth's crust, and the earth will always soak up or carry off, more or less readily, all the water that may descend on it. So, too, the early electricians found that by connecting one side of their frictional machines to earth—in this case the floor of the room—they could go on generating electricity as fast as it was discharged from the prime conductor. They found, too, that connection to earth in the form of their own person was fatal to a certain class of experiments.

Later on, also, when it was discovered that an electric current sent through a wire carried above the ground would return to the place of generation through the ground, the same idea prevailed. Old text books tell the student to regard a galvanic battery as an apparatus something like a pump drawing water from a well, able to draw an inexhaustible supply of electricity from the ground at one place, and to pour electricity into the ground, *ad infinitum*, at another place.

A study of old text books, and even some modern ones, will play rare havoc with the ideas held about "earth" in connection with electric lighting supply, for instance.

In charging the electrophorus, for example, the student is told to put the brass plate to "earth;" to discharge it, in fact, by touching it with his finger. And the plate was, and is, so discharged. Fancy trying to discharge a 10,000 volt transformer in that way.

About the time of the advent of the telephone, it began to be realised that the part played by "earth" as a return for telegraph circuits was not exactly what it had been supposed. It was gradually recognised that the return current passed through the surface of the earth's crust, using whatever paths might be open to it, very much in the same way that the current passed in the wire forming the other portion of the circuit above ground. The only difference between them was that, while the locality of the current passing in the wire was fairly certain, that of the current passing through the ground was not so certain. A portion of the return current from Manchester to London, for instance, might go round by way of Glasgow or Aberdeen, if there happened to be a path for it by either of those routes.

The development of the telephone, with its often troublesome "cross talk," which was traced to earth connections, in a great measure gradually drove the old ideas of the reservoir quite out of the field. Especially was this so when it was reported from America that messages sent in one telephone wire had been heard on another telephone wire separated six miles from the first, the only possible connection being the earth's crust to which both wires were connected.

Gradually it came to be recognised by practical men that "earth" consisted of the conducting matter, such as moisture, mineral veins, &c., held in the earth's crust, with any metals buried there. But then came another trouble over this question of earth. How did "earth" effect a lightning discharge? and what was "earth" for a lightning rod? Surely the old idea held good here? Lightning came down the copper rod to "earth," and was discharged. Unfortunately, lightning does not always behave in this proper fashion. Prof. Oliver Lodge has rearranged our ideas upon this point. He has even maintained that the "earth" our forerunners worshipped is rather a drawback than otherwise. Some of us still believe in "earth" for lightning rods, though we prefer it of a different form usually to the old patterns; our views in the matter being based upon what we have learnt as to the use of the conductors in the earth's crust and in connection with other apparatus.

And, now, when we are congratulating ourselves upon having at last reached the dignity of supplying electric light from generating stations, just as gas has been supplied during the memory of the oldest of us, comes "earth" again, but it means something quite different, and yet the same.

Now, if a man standing on the ground touches an electric light wire carrying a high tension current, and receives a smart shock, he is said to have "earthed" the line, or the electric light service, through his body. So, too, when a naked copper wire, used for delivering current to a series of arc lamps, touches an iron lamp-post, and thereby interferes with the working of the lamps beyond, it is said there is "earth" on. Again, when the possibility of users of electric light, who are supplied by high tension currents, getting shocks is discussed, we are shown various devices for putting the circuit to "earth," should such a contingency arise.

But in these cases the meaning of "earth," though sufficiently the same as in those previously noticed to warrant the retention of the name, is really quite different. "Earth" is not necessary in these cases, as it was in the early days of electricity, with frictional machines. Nor do we use "earth" to save us one cable, as we do with telegraph wires, and as we may with telephone wires.

It is true that in a recent lawsuit over some electric lighting patents "earth" was brought very much in evidence; but it was shown that what was meant was an uninsulated metallic return cable, and that the cable might be insulated if you liked.

It is also true that certain electric tramways in America, and in this country, use what they call "earth" for their return current; but they do not mean "earth" in the old sense—they mean a set of conductors, the rails that happen to be on the ground. In electric lighting work we get as far away from "earth" as possible. To any but electrical engineers of considerable experience a recent report that has been made by a Board of Trade inspector must be exceedingly puzzling. Shocks were obtained from the water service in a house in St. James, and a gas meter had one of

its sides, which rested against a damp wall, eaten through by electrolytic action. The water and gas service is referred to as being several volts above the conduit in which the cables of the Electricity Supply Company were laid; and further on it is stated in one part of the report that earth, which should be absolute zero of electrical potential, had a difference of 190 volts with one of the supply mains, the normal pressure of the service being 220 volts? What does all this mean? What does "earth" mean here?

In connection with electric light supply, where two insulated cables are used, "earth" may be taken to mean any conductor, such as water and gas pipes, iron conduits, &c., that may be present in the ground, and which are all more or less all in electrical connection with each other, by reason of the moisture which is held in suspension in the soil, as well as in bricks, wood, and even in the hardest stones present.

But, and here is the point where this "earth" varies from what we called "earth" before. These masses of metal, damp ground, &c., should have no connection with the electric lighting service at all; they are at absolute zero, because they are, or should be, absolutely neutral. Whenever they become connected, either directly or indirectly, with any portion of the electric lighting circuit, they are no longer at zero of electrical potential, because no longer neutral, and form part of the electric lighting system, just as if they had been regularly calculated for and laid as the cables were: and the danger, when such a connection exists, is not from any reservoir having been suddenly tapped, as a water-bearing fissure may be in a mine, but in the suddenly bringing within the influence of the electrical pressure created at the central station, of a system of conductors that are of uncertain and varying measurements, and quite beyond the control of the engineer.

REVIEWS.

Notes on Design of Small Dynamo. By GEORGE HALLIDAY. London: E. & F. N. Spon, 125, Strand. 1892.

This book is a mere skeleton work of some 80 pages, and is intended mainly to supply drawings for a small reliable dynamo of a well-known type, and to teach students the constructional features of machines. We do not attach much importance to the building of small dynamos, and should not be surprised if the student finds considerable difficulty in the way, especially if he generalises from the statements given here and attempts to vary the winding. As every manufacturer will admit, there are numerous pitfalls in the subject, and even the professional designer frequently *stumbles* with a small machine.

The other object of the book has our sympathies, and we think it will prove useful to students attending lectures on dynamo construction; although we object strongly to the use of such a term as a "hop." There is no need to use such frivolous nicknames, and, indeed, the unit designated by this has no place in the drawing office. The *hop* is defined by Mr. Halliday as the unit strength of armature field, and is such "that one volt is generated along a wire when it moves through one inch of field in one minute." And the expression for the E.M.F. in the armature becomes:—volts = *hops* × twice area polar cavity × revs. per minute × number of turns on periphery of armature.

The value of the *hop* will vary between ·00001 and ·00002, and it is only fair to add that the author has compiled a table (page 33) connecting *hops* with the corresponding field densities in both wrought and cast iron; and he has also given the relative areas of wrought and cast iron to be used with different numbers of *hops*.*

The chapter on journal dimensions is instructive, and the table of sizes of bearings of Edison machines given at the end of it shows how far the "formulæ fit the line" of American practice. At the conclusion of the book there are some excellent tables giving dimensions of commutators and Edison field magnets, and also others giving the possible number of wires round the periphery of armatures, and bobbin winding data.

By far the most valuable information in the book, however, is reserved for the final page. This is a table connecting induction per square inch with ampère turns per inch length of iron for ordinary laminated Swedish iron. We have had no such curves published since the Hopkinsons gave their classical paper on the predetermination of the characteristic of dynamos, and so these fresh determinations give comparative data, and, being in workshop units are at once serviceable for the designer. If Mr. Halliday would give a series of such tables prepared from tests of ordinary wrought and cast-iron as used for dynamo magnets to-day, he would confer a benefit on the profession. The experimental difficulties in the way of making such tests are but few in the laboratory; though they are usually insurmountable in the general run of testing rooms attached to engineering shops; thus the practical dynamo designer is fain to work with old curves, corrected empirically by his experience to suit the particular iron in use.

Continental Electric Light Central Stations; with notes on the methods in actual practice for distributing electricity in towns. By KILLINGWORTH HEDGES. E. & F. N. Spon, 125, Strand, London; and 12, Cortlandt Street, New York. 1892.

This book is mainly written to enable the members of lighting committees and others interested in the introduction of electricity, to obtain a rapid survey of what has been done abroad, both with large and small plants It certainly will attain this end, and will no doubt also prove useful to the electrical engineer engaged in town lighting. Continental experience is more extensive than our own, and a description of a number of foreign plants is a valuable addition to the literature of the subject. The book is conveniently divided into three parts, the first dealing with high pressure distribution with alternating currents and transformers, the second with low pressure distribution by continuous currents, either direct, or with secondary batteries; and the third treats of a variety of interesting points connected with town lighting, such as measuring instruments, conduits, relative cost of electricity and gas, &c. There are 19 high tension and some 34 low tension plants referred to; so it seems that a distribution at about 100 volts gives the most economical results. This is, we believe, in accordance with the experience gained in Great Britain, if the coal consumed per unit delivered is taken as the criterion. We are, of course, aware, that coal is not the only factor of importance, but still it is a fair guide for the commercial efficiency of the power station since the boilers, engines, and dynamos must be of sufficient size to give the energy implied in the coal consumed. The chief difference between the two systems apparently lies in the quantity of energy wasted in the feeders, distributing mains and the service devices. Whether the use of sub-distributing transformer stations will raise the average efficiency of the transformer systems to that of the low tension ones is as yet not proved. The future will show this, and until then we reserve our judgment.

The three-wire system, says Mr. Hedges, has been largely developed by Messrs. Siemens & Halske of Berlin. This firm finds it to be the most suitable arrangement for distances up to 1,600 yards from the central stations; and for larger areas they have used as many as five wires. With this number of mains the economic radius is about one mile and a half. They have also used equalising dynamos on such system, with some success. The use of dynamos in this manner is not yet general in England, and we will refer to it a little more in detail. Suppose we are considering a three-wire system, ordinarily there will be two dynamos, and the middle wire will be in contact with the negative brush of one machine and the positive of the other; the equalising dynamo will give twice the volts of these machines, and will be coupled to feeders joining the outside mains at any point where the potential is likely to vary. As long as the two main dynamos are capable of supplying the current required at the proper potential the equalising dynamo will give little or no current; but as soon

* And on page 67 we find the same table with a new nickname for the *hops*, namely, *kapps*. We assume that this confusion has arisen in consequence of uncertainty in Mr. Halliday's mind as to the man who most deserved to be associated with the new unit. It is still further increased by the use of *kapps* on page 20 in the equation for armature volts; although on page 6 the particular value represented is defined as a *hop*.

as the potential falls it will supply current to the mains at the normal potential and thus tend to keep a constant E.M.F. over the system. The current required from the equalising dynamo will depend on the size of the mains, the equality of distribution of the load between the two main dynamos, and, also, on the variations of the total output. Mr. Hedges, in his diagrams on page 111, make the equaliser larger than the main dynamos, which implies a large variation of load. This method of regulating the E.M.F. of supply must not be confounded with the constant current converter equaliser, also used on the continent, and in a manner similar to that adopted at Oxford.

The illustrations of plants, machines and details are numerous and mostly well delineated, so that the non-technical reader will be able to understand the points referred to in the text. At the end of the book is a small glossary of technical terms, which should prove useful to vestrymen and town councillors.

ERECTION OF AN ELECTRICAL CENTRAL STATION AT TRIESTE.

[FROM OUR OWN CORRESPONDENT.]

ON the order of the day for the meeting of the Municipal Council (June 23rd), there was to be a proposal respecting the erection of an electrical central station at the cost of the community. As we may presume that the previous history of the question—ventilated for many years—of the introduction of the electric light along with gas is fully known, we confine ourselves to summarising the most important points of the report on the proposal which was to be discussed. After the report has recapitulated the previous history of the matter and pointed out that the question of expense induced the special committee of the town council entrusted with the elaboration of the proposal to suggest merely the erection of one central station to be worked by steam, it accompanies the concrete proposals with the following details:—After mature study, the plot of ground in Via Fornace, which is the exclusive property of the community, is proposed for the erection of a central station. This plot is situate on the eminence where stands the Capuchin Monastery, at the point where the road to the monastery meets that leading to the plateau of the hill at the opening of the Scala dei Giganti. From this plot of ground the length of the wire to the Polythema, the Riunione Adriatica, the Assicurazioni Generali, and the new Post Office, is each 900 metres, to the Lloyd Palace 800 metres, to the Government buildings 750 metres, to the Town Hall and the Council Hall 700 each, to the Tergesteum and the Communal Theatre 600 metres each, to the Fenice and the Hospital each 500 metres, to the Filodramitico 300 metres, and to the Armonia 200 metres. Although this plot of ground lies on the slope of a hill and 50 metres above the level of the wood market, the erection of a central station is still practicable. With reference to the difficulties of the ground, the expenses of construction, if we have gas engines, will run to 197,000 florins for 2,000 lamps, and to 379,000 florins for 6,000 lamps, whilst in case of steam motors the expense for 2,000 lamps will be 180,000 florins, and for 6,000 lamps, 327,000 florins. From the investigations made by the committee, there resulted the fact—remarkable at first sight—that the quantity of water required for cooling down the gas motors is much larger than that needed for the direct production of the steam needed for conversion into electrical energy. On the basis of these results, which speak positively for the erection of a single electric station at no great distance from the city, and for steam engines as against gas engines, the committee concentrated its attention upon ascertaining the outlay for erecting, working, &c., a single central station to be placed on the plot of ground above mentioned, and to be worked by steam power. The building, planned in quite a simple style, devoid of ornament, must be so roomy that the groups of machinery can be raised to the extent required for feeding 6,000 lamps, where each single group of machines is calculated to produce electric light sufficient for feeding 2,000 lamps at 16 candles each. As regards guaranteeing the remunerative character of an electric station conducted on municipal account, the committee took its stand on the idea that the theatres and the halls, which serve for public meetings, must be electrically lighted on account of public health and safety.

As to the future demand for electric light on the part of private persons, the committee cannot, of course, lay down any figures with mathematical certainty. But an approximate estimate may be given by assuming that the theatres, the Great Square, the more frequented part of the Corso, and the Council Hall will have to be lighted electrically, and that the places of social assemblage, especially cafés, restaurants, and business houses will readily adopt the electric light supplied at an easy price, we may certainly look forward to a demand for 2,000 lamps, probably indeed of 4,000 lamps, and leave to the future the demand for 6,000 lamps and upwards. The price of electric light at those centres where it is introduced is, on an average, 2·5 kreuzer per lamp hour. But as in Trieste the cost of water is much higher than elsewhere the committee estimate the sale price of the light at 3 kreuzer per lamp (16 candle) hour. The committee concluded that the simultaneous working of the stations for supplying gas and electric light on municipal account cannot lead to any injurious competition. Being convinced that the erection of a central electric station in the hands of the community will prove itself a safe source of income, that with the extension of the electric light the sanitary conditions and the security in public assemblages will be improved, and that lastly a uniform illumination of the great square and of the Corso, the main artery of the city, will promote decorum; the committee proposes the creation of a central electric station and formulates its conclusions as follows:—

1. That the erection of a central station on the plot of land belonging to the community No. 149, at first for 2,000 lamps, to be subsequently increased to 6,000, to be conducted on account of the community, be accepted.
2. That the electric lighting of the theatres be declared obligatory.
3. The municipal delegation shall be authorised to apply to electro-technical establishments for tenders for the erection of the central station and for the laying of the mains, according to a programme to be accurately determined, and on a guarantee for 10 years.
4. That a credit of 200,000 florins for the erection of an electric central station and as the requisite working capital.
5. The municipal delegation is commissioned, after obtaining the opinion of the finance committee to make a proposal for covering the above mentioned proposal.
6. The municipal magistracy is entrusted with carrying out the requisite steps for obtaining the concession.

AUSTRALIAN ELECTRICAL NOTES.

[FROM OUR OWN CORRESPONDENT.]

THE contract has just been let to Messrs. H. H. Kingsbury and Co. for the lighting of two of the Balmain ferry boats plying in Sydney Harbour. It is understood that in the event of the first two being successfully lit, a larger order will follow; and the fashion once set, it is probable that other companies may follow the lead. About 20 lamps will be fitted in each, including the side lights. Mr. Kingsbury proposes to instal on each a 2 horse-power Parsons steam turbine and dynamo combined, and as these machines are as yet unknown in practice in this country, the result will be watched with some interest. Precautions are to be taken against the accidental extinction of the port and starboard lights by arranging for an automatic "cut-in" for bringing a spare lamp into circuit immediately the one in use goes out, at the same time ringing a bell to attract the engineer's attention to the fact, in order that he may replace the broken lamp by a new one, ready for the next emergency.

The same firm are also replacing by the latest style Brush lamps the present Weston arc lamps, seven in number, which have been running regularly at the Redfern Station since they were first put in by Mr. Kingsbury 10 years ago. The installation is to be further increased by the addition of 90 16-candle-power incandescent lamps for the waiting rooms, offices, &c.; and the present plant at the

railway station is to be abolished, and both the arc and incandescent lamps run from the plant at Eveleigh, a station about a mile from Redfern, where all the locomotive shops, clearing sheds, &c., are. The plant now at Eveleigh consists of two 500-light 110-volt Edison dynamos, new pattern; two 250-light 110-volt Edison dynamos, old pattern, with long field magnets, put in some seven or eight years ago; and four 20-light 1,000-volt Brush arc-light machines. Some 500 incandescent lights are used in the passenger-car cleaning shed alone, the remainder being distributed in the other sheds, shops, and offices, the arc lamps illuminating the yards, turn-tables, and sidings. At the railway sidings at Clyde, about 13 miles from Sydney, use is being made of the arc-light as an illuminant; using 30 15-ampère 50-volt Brockie-Pell lamps, constructed to burn 32 hours without attention or re-carboning. These lamps, which extend over a circuit of rather more than three miles, are placed on 40 feet ironbark poles, set in iron steps, and are run in parallel from a Crompton dynamo, driven by a 50-horse-power Westinghouse engine; Messrs. Kingsbury & Co. are also reponsible for this plant.

The Brush Electrical Engineering Corporation have just secured the contract for the lighting of the new Lyceum Theatre and Hotel in Pitt Street. This theatre, which when completed, will have the largest stage of any theatre in Australia, is to be fitted with all the most recent appliances for producing the multifarious effects for which electricity has shown itself so well adapted; the stage alone will be supplied with some 500 16-candle-power incandescent lamps. The total capacity of the installation when complete will be for the supply of over 900 16-candle-power incandescent lamps for lighting the interior of the theatre and hotel, and three arc lamps to be placed outside the building. The plant being put in at present consists of a 660-light Victoria Brush dynamo, driven by a Brush vertical engine of 80 horse-power, supplied with steam at 100 lbs. pressure from a multitubular boiler of local manufacture. The supply and erection of the whole plant, wiring and fitting included, has been placed in the hands of the Brush Company, who intend doing the whole of the wiring, &c., in accord with the regulations of the London County Council.

The contracts for the Melbourne municipal lighting have been awarded exactly as expected, with the exception of the contract for the cables, the award of which came as a surprise; the results were as follows:—Boilers, Messrs. Babcock & Willcox; engines and pumps, the Austral Otis Company of Melbourne; electrical machinery, the Thomson-Houston Company; and cables, the Okonite Company.

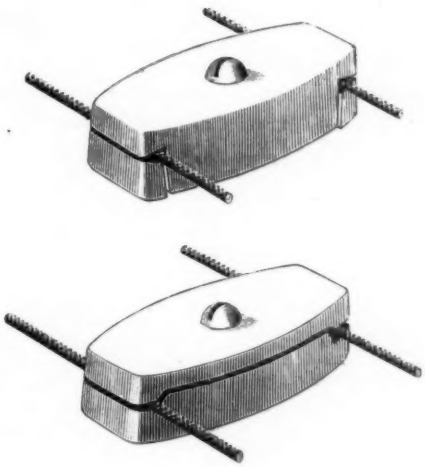
I regret to have to record another fatality in Melbourne, undoubtedly caused by electricity. On Saturday, May 28th, a heavy thunderstorm broke over Melbourne, one of the high tension electric light wires supplying the Public Library was broken in some way at the corner of Russell and Lonsdale Streets. Some one warned the crowd, which immediately collected, not to touch, and ran off to apprise the engineers at the central station and have circuit cut off. A bystander noticing the end of the wire, presumably the insulation, burning or smouldering, attempted to extinguish it by placing it in the gutter, and received a shock which knocked him down. Shortly afterwards a man named C. H. Andrews, who, I imagine, supposed he knew "all about electricity," took hold of the wire and commenced rolling it up, and no difficulty occurred until his hand found a weak spot in the insulation, when he also, of course, received a powerful shock which threw him to the ground, and he was unable to release his hold of the wire. A friend of his named Wells, with the intention of assisting his companion, seized Andrews by the wrist and was also thrown down. The crowd were then afraid to touch the wire until a man procured an axe and severed the wire and released the two men, when Wells was found to be dead, and Andrews very badly shaken and hurt. The circuit in question carried a 2,000-volt alternating current from the New Australian Company's city station.

The final hearing of the incandescent lamp patent case came on a few days ago, and the defendant, Mr. Kingsbury, being away in Brisbane at the time, and his solicitors failing to put in an appearance, the Brush Company gained a verdict without a struggle. In view of the fact that the defendant's solicitors were much at fault it is possible that a new trial might be asked for, especially as the judge in summing up made some distinctly unkind remarks about the defendant's absence, which was purely an accident, Mr. Kingsbury at the time of the trial being disporting himself gaily in Brisbane quite unconscious that the case was to be tried.

Sydney, *May 30th.*

TWO-WIRE PORCELAIN CLEAT.*

THE Security Insulator Company, of 136, Liberty Street, New York, realising the need of a two-wire porcelain cleat that would be cheap, practical and effective, have perfected what they call the "Security" cleat. It is really what its name implies, a secure cleat, inasmuch as the wires are held



securely in their places without kinking the wire or injuring the insulation. Like the "Security" insulator, wires of different sizes can be used with the same result, and that an eminently satisfactory one. The accompanying cut shows both front and back views of the cleat, and are about one-half the actual size.

A LIFE AND EFFICIENCY TEST OF INCANDESCENT LAMPS.

THERE is a great divergence between the published claims of lamp makers and the statements of the experience of station managers, say Prof. Thomas and Messrs. Martin and Hassler in a paper read by them before the American Institute of Electrical Engineers, and the truth of this statement becomes very apparent when one reads the figures given in the paper as the result of tests on 127 lamps of American make. These lamps were all marked for 110 volts and 16 candle-power; and, as the object which the authors had in view was to obtain results from commercial lamps, such as were sold to ordinary consumers, some of the lamps were bought from regular dealers, and others were taken from lots supplied for central station use. The 127 lamps were divided into 13 lots, there being 17 lamps in two lots by one maker, and 11 lots each of 10 lamps by 11 other makers, the 12 makes represented in the tests being as follows:—A. B. C., Beacon, Columbia, Economic, Packard, Pennsylvania, Standard, Thomson-Houston, Edison, Perkins, Sawyer-Man, and Steuben.

In publishing the results, the authors have designated each lot by a letter, instead of giving the maker's name, as they considered that it would be hardly fair to give the name in connection with the results of the test, owing to the comparatively small number of lamps of each make which were tested; a number which, in their opinion, was too small to

* New York *Electrical Review.*

base a fair judgment on as to the relative merits of the lamps generally sold by the several makers; but at the same time they express the belief that the average of the results of all makes may be taken to represent fairly well the character of the ordinary commercial lamp, as supplied in America. The results of the test are summarised in the following table, which gives for each lot the mean horizontal candle-power, and the watts per candle-power at the beginning and end of a run of 1,000 hours, and also the values of the average illuminating power, the average efficiency, and the ratio of minimum to maximum candle-power during this period; these latter values having been calculated from the figures quoted in the paper, and added in the table below, as they are the figures which are, perhaps, more useful than any others in determining the economic value of the lamps :—

Type of lamp.	Mean horizontal candle-power.			Watts per candle-power.			Minimum C.P. / Maximum C.P.
	At start.	After 1,000 hours.	Average.	At start.	After 1,000 hours.	Average.	
A	16·0	8·6	11·47	3·9	6·8	5·48	·54
B	13·1	8·2	10·01	4·4	7·1	5·97	·62
C	14·1	12·6*	14·10*	5·4	6·7*	6·00*	·82*
D	16·1	9·2	12·61	4·3	7·2	5·68	·57
E	15·9	7·6	10·58	4·1	7·4	5·77	·49
F	14·2	8·0	10·35	4·1	6·8	5·47	·56
G	17·1	10·4	13·37	4·2	6·7	5·53	·62
K	17·0	9·8	12·80	3·9	6·4	5·21	·58
L	13·2	7·1	8·77	3·8	6·2	5·40	·54
M	12·5	8·8	10·63	4·8	6·1	5·29	·70
N	14·1	7·4	9·42	4·4	7·5	6·25	·52
O	17·0	8·0	11·71	3·9	7·9	6·00	·47
P	14·6	8·4	11·05	4·0	6·2	5·18	·54
Average	14·99	8·46	11·06	4·24	6·86	5·60	·562

* Calculated on 800 hours instead of 1,000, and not included in calculating the average of all makes.

A glance at the table shows that the best initial efficiency obtained is 3·8 watts per candle, and the worst 5·4 watts per candle, whilst the efficiency at the end of 1,000 hours burning varies from 6·1 to 7·9 watts per candle; that only five lots out of the thirteen give an illuminating power of 16 candles or over at any time; and that if the average of all lamps is taken, as suggested by the authors, the result shows that in America the commercial lamp rated at 16 candles may be expected to give about 15 candles at the start for an expenditure of 63·6 watts, about 8½ candles after 1,000 hours' burning, with an expenditure of 58 watts, and an average illuminating power of about 11 candles with an average expenditure of 61·6 watts. These results are far below the 60 watts for 16 candles which is so often assumed, and certainly suggest that the 50-watt lamp, about which mention is made in company's circulars, must have an illuminating power much nearer 8 candles than the 16 which is generally inferred, if not actually stated in the claim.

With regard to the variation of illuminating power, the table shows that two lots of lamps gave at the finish less than 50 per cent. of their maximum candle-power, and that only three lots gave more than 60 per cent. of their maximum at the end of 1,000 hours. In four cases the initial candle-power was not the maximum, a characteristic which appears fairly common with American lamps, as a good many of those tested by Mr. W. H. Pierce showed also that instead of the gradual falling off, which generally occurs in European lamps, there was a decided increase of illuminating power during the first 100 or 200 hours. This is especially noticeable in the lamps marked C, which gave at the end of 200 hours nearly 10 per cent. more candle-power than at the start, and actually have the same values for the initial and average illuminating powers. The lamps in this set give in other respects rather abnormal results as none of them lasted more than 800 hours, notwithstanding the fact that they were run at an average efficiency of 6 watts per candle, and that at no time did they take less than 5·4 watts; and further the variation of illuminating power during the run was much smaller with these lamps than with any others, the candle-power at the finish being 82 per cent. of the maximum observed during the run.

The general conclusions to be drawn from the results given in the paper are not very flattering to the American lamp manufacturer, as the figures given do not compare well with those obtained from lamps of European make, such as, for example, those obtained from the tests made at the Vienna Central Station in 1888, the results of which were published in a letter communicated by Mr. Dobson to the ELECTRICAL REVIEW of the 17th October, 1890, and showed that the 16-candle-power lamp gave an average result of 11·5 candles with an expenditure of 4·86 watts per candle, and that of these lamps the Swan lamp headed the list with 15·1 candles for 4·25 watts per candle-power.

ELECTRIC TRANSPORT FACILITIES ABROAD.

SOME time last year the Department of State, Washington, addressed to the consular officers of the United States a local transportation circular, asking for information concerning the systems of public transport obtaining in the different consular districts. The object of the circular was to obtain data for the information of the municipal governments, and the people dwelling in cities in the United States. These data have now been embodied in a report issued from the Department of State, Washington, and from which the following concerning electric lines is abstracted.

In Vienna, there is a suburban electric railway to one of the summer resorts. This starts from Moedling (a station on the Southern Railway about 10 miles from Vienna), and runs a distance of about five miles through the Hinterbruehl Valley. The current is produced at a central station, and passes along the line by means of overhead conductors, from which it is conveyed to the motor on the car by trolleys. This electric railway belongs to a company, and a fare of 25 kreutzers (about 5¼d.) is charged per ticket. The line is operated under the same regulations as the steam and horse cars, but the speed is only allowed to exceed by a little that of the horse cars. The various systems are said to be highly profitable to the parties owning them.

In Paris, in addition to omnibuses and horse tramcars, there are street cars operated by steam engines without fire grate (Francq system), with fire grate and without smoke (Rowan system), automotor cars (Mekarski compressed air method), automotor or storage battery cars on trial on the line from Levallois-Perret to the Madeleine; and a funicular cable system from the Place de la Republique to Belleville.

There is now an electric line in Bremen, which amply supplies the means of transportation required by the population of Bremen and Bremerhaven.

The electric tramway on the trolley system from Frankfort to Offenbach, a distance of five miles, has to pay the municipality of Frankfort 3 per cent. of that part of its gross earnings, which is proportionable to the portion of its line which is within the corporate limits of the city. In view, however, of the limited business of the line during the first two years of operation, its contribution to the city for 1889 and 1890 was remitted by special enactment; but the above regulation is the one under which the tramway was built, and its conditions will in future be enforced. The line is in direct competition with an old and well-managed steam railway, and the owners are therefore compelled to fix its fares for the entire ride of five miles at 2½d., and for the round trip or return journey at about 30 pfennigs, or, say, 3¾d. The competition of the electric line and the steam railway is very keen, and it is said that many years will elapse before the Frankfort-Offenbach tramway may be expected to pay substantial dividends.

In Florence there is a system of electric cars connecting the city with the ancient Etruscan town of Fiesole. This line, which is 4½ miles long, is owned, as is the steam tramway to San Casciano, by a Florentine company, and is managed by the banking firm of Fenzi & Co. The fare for the whole distance is 7d.

In the northern suburbs of the City of Toronto there is a system of electric cars where there is a universal fare of 2½d. The owners of the line do not pay anything to the city or county for their rights. It is anticipated that in two years there will be no horse cars in use as the public is insisting upon electric cars.

AMERICAN ENGINEERING NOTES.

GRAPHITE AS A LUBRICANT.

AMERICANS are often so hopeful and sanguine, that it is a pleasure to read some of the papers presented before their engineering societies, even though we may not always agree with their conclusions. Amongst the papers presented at the San Francisco meeting of the mechanical engineers of considerable interest, we note one on self-lubricating fibre graphite for machinery bearings. There is a pretty wide claim involved in even the title of the paper, but none too wide if the material pans out to the assay claimed for it by the reader of the paper. It is stated that experience has proved the new material to be uninjured by prolonged contact even under *modern*, by which it is evidently intended to convey the idea of heavy pressures and high velocities, with water, oils, acids, alkalies, and high temperatures, whilst it also does not vary in bulk with temperature, as do metals. The new bearing material is composed of finely divided—presumably levigated—and purified graphite, to which is added wood fibre, mixed in water according to the purpose required of varying proportions of fibre to graphite, then solidified in moulds by pressure, dried, saturated with some drying oil, and oxidised in hot dry air. Thus completed, the material can be machined, and is applicable to every variety of bearing, from cotton spinning spindles to gas check rings in guns.

Graphite as a lubricant is so well known as a good material, especially in heavy bearings, that surprise need not, perhaps, be felt at the success of the new material, which appears to owe its success to being a convenient means of converting a lubricating material into the bearing itself, just as if sperm oil, if convertible like water into a frictionless solid, would be an almost perfect bearing material. Water is thus convertible, but its solid form is not easily maintained in practice, and in its liquid form water has not sufficient viscosity.

A few years ago there was a serious attempt to introduce an oilless bearing material, which was termed metalline. One such we remember to have seen at an industrial exhibition in Oldham, applied to the spindle bearings of a spinning frame, and to the crosshead guides of a steam engine, and we saw it also applied to shafting and to the spindle of a drill press. This substance was, however, made in the form of little plugs, let into drilled holes, and was, of course, expensive to put in place on account of the large amount of drilling necessary. The chief ingredient of these metalline plugs, however, was not graphite, but finely divided lead, mixed with other substances, amongst which we suspected graphite to have a place.

For the new fibrous bearings it is claimed that the average for a series of 128 tests showed for cotton spindles a clear average saving of power of 25 per cent. the smallest saving in the series being 17 per cent. A step bearing in water formed to an obtuse angled cone of 2 inches diameter, carried at 470 revolutions per minute a load of 100 lbs. per square inch for three months without total obliteration of the tool marks, and various other severe tests are quoted in the paper including tests on a dynamo, of which the paper says :—

"In the dynamo brush made of this material we have the combination of perfect lubricity and ample electrical conductivity in one solid piece, which may be adapted in form to every requirement of dynamos and electric motors." Should longer experience prove equally reasssuring the new material will certainly come into general use. There always appears something unmechanical in the use of oil and other liquid and semi-fluid materials with all their dirt and inconveniences.

A FORM OF SINGLE ACTING COMPOUND ENGINE.

Another paper by Mr. F. M. Rites deals with a form of single acting compound engine, and the distribution of steam between the two cylinders. The author notices the two methods of compound working which have been used in the past, namely the continuous expansion or Woolf system, and the receiver engine, and he speaks incorrectly of the Woolf type as practically unknown, whereas it is far from unknown and may be found to a large extent in France. He correctly refers to the loss which results when receiver engines are so worked as to cause a loss of pressure between the two cylinders, and he appears, so far as the matter in his paper extends, to hold the idea that receiver engines are always so worked. We do not say he does hold this mistaken idea but he certainly leads one to suppose from the manner in which he treats the subject in hand that his method of dealing with the distribution of steam in his compound single acting engines is both new as an application to such engines and to *any* compound engines whatever, whereas it is ancient history, to the present writer's knowledge, for years past, and is well known as a means of equating the power and temperature ranges between the two cylinders when the duty to be performed is not that best suited to the size of engine.

The advantage of early cut-off of steam in the final cylinder of a compound engine was first forcibly brought to our notice in pupilage days, in the case of a MacNaughted beam engine in the town of Ashton. As customary when the high pressure cylinder was added, the automatic cut-off on the old—now final—cylinder was put out of gear, but the "engine tenter" put it into operation again at about half or three-eighths stroke with a marked immediate saving in fuel.

The object taught in the design is the coincidence of the exhaust line of the high pressure cylinder up to closure with the admission line of the low pressure cylinder and the receiver volume, v, for this end for a cut off of 50 per cent. in the first cylinder is such that v : H.P. vol. :: H.P. vol, : L.P. volume, whilst it is stated that for other cuts-off varying on either side of the half up to practical limits, any error can be corrected by the angularity of the eccentric rod, causing the variation of the H.P. cut-off to be more rapid than that of the L.P. cut-off.

It is not unworthy of note that the practice in this country has always pointed to some such similar conclusion for ordinary factory engines. In the single valve of the paper the reservoir capacity of the volume, as found by above rule, is secured by an annular semicircular shaped passage or chamber of a piston valve which slides transversely across the ends of the two cylinders. The smallness of the receiver capacity gives to the diagrams a close resemblance to cards from a Woolf type engine.

The design intends compression in the first cylinder up to boiler pressure, and in the low pressure up to the terminal in the first cylinder, this latter to our way of thinking being perhaps the most important point to be considered in compound working, and the one which eliminates the fall of potential, which is so serious a matter in compound working.

However commendable the aim and object of the paper, we cannot however allow the claim that "this design has undoubtedly originated the principle of overcoming by a proper compression the otherwise great waste of a large high pressure clearance chamber," for the author will find the subject treated, if we mistake not, about the year '88 in the *American Machinist*, whilst it has been common knowledge in the Lancashire district before that time.

BURSTING OF A BELT PULLEY.

One of the more decidedly practical papers read before the American Society of Mechanical Engineers at San Francisco, has reference to the bursting of a belt pulley of 30 feet diameter, and 110 inches face, at the Amoskeag Manufacturing Company, N.H., on October 15th, 1891. The ordinary speed of the wheel was 61 revolutions per minute, or 5,750 feet peripheral velocity, and the wheel burst without stopping a loom, which would have automatically "knocked off" at 75 revolutions of the engine. The wheel had 12 arms, and weighed 116,000 lbs. and it is sufficient here to say that the rim and arm ends were thoroughly bad castings, and hence the failure.

The interest of the paper centres in the reconstruction of the wheel to the same dimensions, but with a double boss, and a wooden rim 12 inches thick and 108½-inch face, this being a common material in America for large pulley rims. As the cranks could not well be removed, the hubs were made in halves, bolted together, the joints of the two hubs being at right angles.

The arms were cast of ordinary tubular form flange bolted to the hub, which we think is inferior to the English method of boring out sockets in the boss, and turning the arms to fit these, and securing by keys.

The rim was built up of kiln-dried Western ash, in courses of 4-inch, 3-inch and 2-inch stuff, reduced ½-inch by dressing, so that in all there are 44 courses or rings, and each ring is in 12 lengths of about 8 feet each. Each piece was attached by glue and 16 lag screws, and between each arm three ⅜th-inch through bolts pass from side to side of the rim. When complete, at a cost of $7,000, or less than its "sinful predecessor," it ran true at 76 revolutions, without sign of failure. All the wood was painted, except the driving face, which was filled with linseed oil, raw, and beeswax, well worked in to exclude moisture. The lag screws were set up rapidly by a quick running flexible shaft, so squeezing up the glued faces while hot.

To compare its strength with a rim of cast iron, the metal is assumed at 450 lbs. per cubic foot, and as having a tensile strength of 1,440,000 lbs. per square foot. Thus $\frac{1,440,000}{450} = 3,200$. Ash at 34 lbs. per cubic foot and 1,152,000 lbs. tensile strength gives $\frac{1,152,000}{34} = 33,882$, or a ratio of 10·58 : 1 as compared with iron, so that its relative strength is $\sqrt{10·58} = 3·25$. As regards increase of velocity, the cast rim, which bursts at, say, 100, would be followed by the wooden rim at 325.

The construction is worth bearing in mind, and so is the old rule for cast rims of 80 feet per second safe rim velocity, for unless these large cast iron rims be run at a high test velocity before being sent to work, the presence of hidden flaws never can be known.

There has appeared a tendency of late to run rims at speeds higher than necessary, and it should not be overlooked that for the working tensions usually allowed to ropes and to leather, speeds of 5,000 for ropes to 7,000 for belts are about a maximum, beyond which centrifugal stress in the rope or belt increases faster than the added efficiency due to velocity, which is uselessly provided. In these flexible connections, the last 1,000 feet of velocity, up to speed of maximum efficiency, is of very small value, and may be played with by the designer and used as a limit of deviation without harm to his design.

Economy of Two Cylinders in Compound Engines.

Mr. Rockwood, in collaboration with Mr. Green, presented a paper to show that more than two cylinders are not required to secure the highest economy in compound steam engines, which proposition seems to us very much on all fours with the statement that one cylinder is enough for any engine, for if compound working with two cylinders be advantageous, there must, one would think, be a limit even to the range of two cylinders, though no doubt this is higher than is often found in practice.

The authors simply took a compound engine and arranged so that they could cut out the intermediate cylinder and work either double or triple.

They obtain the following results into the method and manner of which we propose to follow them in order to see whether their contention is one likely to be borne out in ordinary practice :—

Test.	Triple or Double.	Revs. per minute.	Pressure.	I.H.P.	Water per I.H.P.	Dry steam per I.H.P.	Water used in Jackets per hour.
A	Double	79·2	142	187·11	13·41	13·06	330·3
B	„	79·3	142	180·71	13·11	12·76	330·3
C	Triple	79·0	142	199·08	13·01	12·67	416·0
D	„	79·0	143	178·16	13·25	12·90	388·8

Now, the L.P. cylinder is 24$\frac{13}{32}$ diameter with a 3-inch rod and a stroke of 4 feet. At 79 revolutions the piston speed is 632 feet, and for 199 I.H.P. a mean pressure, referred to the last cylinder, will be obtained from a net effective pressure of 22·4 or, we will say, a mean forward pressure of 25 lbs., and with an initial pressure of about 158 lbs. absolute, implies a thirty-fold expansion, or close upon this, which in our opinion is too much, and shows that to begin with the engines were underloaded, and this is borne out, too, by the triple expansion cards, of which those from the first cylinder show for nearly half their length absolute coincidence of the expansion line and the exhaust, while all the low pressure diagrams show a terminal less than half an atmosphere. The cylinder ratios are 1 : 1·83 : 5·7, and this, while merely referred to by the authors as somewhat novel, is explained as due to the designers' desire to give a symmetrical appearance to the engines and uniform turning movement, and does not strike us as specially suitable as a triple engine ratio so much as it does as a double cylinder ratio.

Neither does the length, 325 feet for the supply pipe, appear particularly suitable for a test engine, and all we can say of this is that it must have been well protected, and the water separator must have been a very good one. We are informed that the first two cylinders were jacketted all over, the last cylinder on the heads only, but the receivers between each cylinder were jacketted, and all jackets had boiler steam at full pressure.

We presume that to the weight of water used that condensed in the jackets has not been added in the table above given. Each test was only of five hours duration, so that there is no allowance for lighting up, &c., merely a record of steam used when under weigh. Further information is promised.

In the meantime the results appear to show the value of reheaters as aids to economy, and good steam and exhaust ports, which, in area, are respectively one-eleventh, one-twelfth and one-fifteenth of the cylinder diameter squared for H.P., I.P., and L.P. for steam, and one-eighth and a-half, one-tenth, and one-tenth for exhaust; and we think they show also the benefits of expansion gear to all cylinders, in place of the customary slovenly looking diagrams of triple engines, though it is always a question whether, in general practice, the economy of a neat indicator card is not bought too highly in view of the excellent results which follow triple expansion with slide valves.

New Type of Steam Boilers.

Underfiring of steam boilers, though not approved in this country, is very largely practised in America, and is employed in the case of a novel type described by Mr. Webber, which consists of a front portion of cylindrical form extending over the furnace, and an oval rear end containing, in the lower part of the oval which extends below the cylindrical front end, a set of short tubes, which lead to an attached box in the rear, like the furnace, lined with firebrick, and forming an uptake to an upper set of longer but smaller tubes, extending the full length of the boiler to a smoke box in front. This fire-brick lining is considered to make the rear box fill the functions of a combustion chamber.

The value of this boiler appears to be in its efficiency per weight and space occupied.

A boiler measuring, overall, 14 feet × 5 feet × 8½ feet high, including dome, weighs, with all fittings, 12,000 lbs., contains 20 tubes 4 inches × 64 inches, and 38 tubes 3 inches × 120 inches, the circular portion of the shell of the boiler being 40 inches diameter. The ratio of grate to heating surface is the common one of 1 : 30, and a grate surface of 14·7 square feet is secured entirely within the volume above named. The best result obtained from a boiler well covered against loss by radiation, was 21·8 lbs. of actual dry coal burned per square foot of grate, and 5·7 lbs. of water evaporated per foot of heating surface from and at 212°.

There was nothing very special in the evaporation per lb. of fuel in the various tests made, but the output of the boiler was good. It was all contained in a floor space of 70 square feet, or less than 5 square feet per foot of grate area, which compares favourably with the Lancashire boiler, which alone, without its surrounding brickwork, occupies six times its grate area.

We think the boiler would be improved if its dome were removed. This renders it far bulkier to ship, and those who have had any experience of the rapacity of shippers who measure boilers for shipment on the largest rectangular cubic measure, will appreciate this. Then, a dome is of no use *anyhow*, as the Americans would say themselves, and we wonder at the conservative tendencies of American engineers in this matter of domes.

THE TIVOLI ELECTRIC INSTALLATION.

[FROM OUR OWN CORRESPONDENT.]

IN Tivoli and at Rome there took place on the 4th of the present month an occurrence which was celebrated as an epoch-making event in the sphere of electrotechnics, and which in all interested circles has been awaited for years with the most eager attention.

The matter in question was the solemn opening of the Tivoli Electrical Works which the gas company of Rome erected as a supplement to the electrical works installed at Rome, and which have been in action for six years and driven by steam to the extent of 2,700 H.P. It was intended to supply at Rome, from the works erected at Tivoli, and working with water-power, current both for public and private lighting and for industrial purposes.

Tivoli was known in antiquity as a district blessed with natural beauties, and served as a country retreat for the luxurious Roman patricians. Even at the present day numerous remains of those old splendid buildings have been preserved.

Tivoli is also very rich in waterfalls, equally beautiful and powerful, which have already for a long time served as a source of power for numerous small industries.

Since 1887 there has been, also, a small electrical works in operation, erected by the firm Gaulard & Gibbs, for public lighting at Tivoli, and working with alternating current transformers arranged in series.

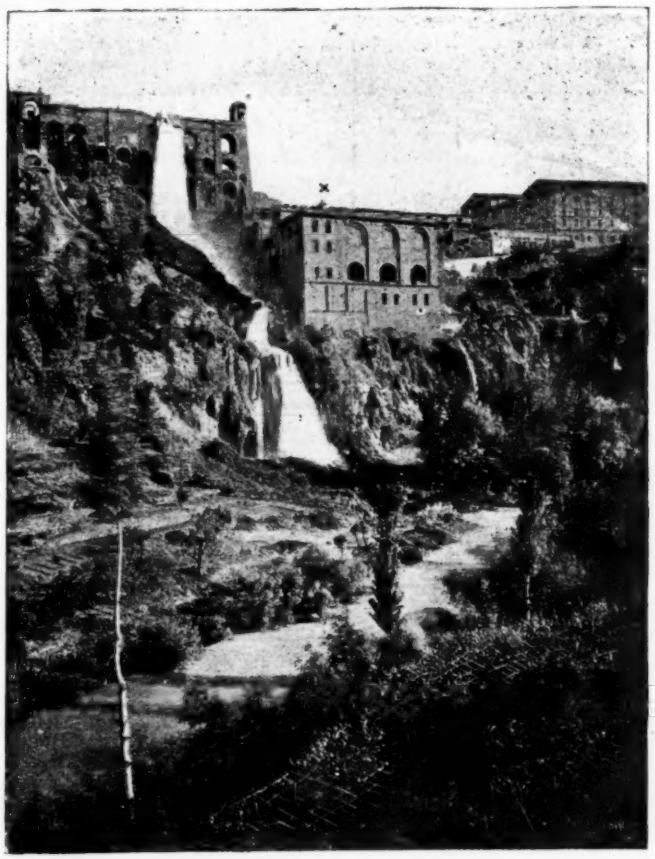
Several years ago a company established under the style, "Società per le forze idrauliche 'ad usi industriale," undertook the utilisation of the waterfalls on a large scale, in order to convey an electric current from Tivoli to Rome, a distance of 28 kilometres. For this purpose extensive waterworks and roads were carried out, and a building for machinery was erected, although the company did not succeed in realising their grand project.

In 1888 the energetic manager of the Roman gasworks, C. Pouchain, took up the idea and conducted it towards its realisation. He bought the installations of the company above named, and proceeded to erect electric works at Tivoli on the extensive plan designed. The works are built in the old Villa Mecenate (the ancient seat of Mecaenas, the prime-minister of the Emperor Augustus) where a waterfall of $3\frac{3}{4}$ cubic metres per second is available with a total fall of about 110 metres, the upper 10 metres of which were already applied for local industrial purposes.

The next portion is conveyed upon an old Roman viaduct through a channel 150 metres in length and 2·7 metres in width, and arrives at the so-called station IV., where the machinery house has been constructed.

This arrangement was derived from the Società per le forze and is partly included in the relations of water-rights.

The above mentioned channel opens into a tower in which has been erected an upright pipe, 40 metres in height, and of the diameter of 1·6 metre. This upright is provided with annular sluices and hastalong the channel long overflow weirs to keep the level of the water constant.



VIEW SHOWING WATERFALLS AND GENERATING STATION MARKED ×.

From the bottom of the upright pipe a sheet metal pipe of the same width passes 50 metres further and conveys the requisite quantity of water into the machinery house at the level of the roof.

The machinery house stands on the declivity of the hill, it is very substantially constructed, and besides accessory rooms contains the machinery hall, 25 metres in length and 16 metres in width.

The main pipe divides itself into three transverse pipes from each of which pass three vertical pipes to the nine turbines.

A very complete system of slides, which can all be manipulated by hydraulic pressure from the machine house, permits each of the three transverse pipes and each of the vertical pipes to be shut off in a few seconds, so that, even in the very improbable case of the rupture of a pipe, the security of the work remains untouched.

Corresponding to the three lines of tubing, the nine machines form three groups, each of which consists of two

turbines of 330 H.P. each, and one in the middle of 50 H.P., each of which is directly coupled with the electric machine which it actuates.

All the turbines are partial Girard turbines. The 330 H.P. turbines have six inlets and rotatory slides; the 50 H.P. turbines have one inlet and throttle valve. The former are constructed for 170 and the latter for 375 rotations per minute.

Each turbine is fitted with a self-acting regulator—Ganz system—which by regulating the afflux of water maintains the speed with the same precision as it is effected in the best steam engines.

The turbines are completely inclosed in protective cases, and the escape of the water takes place underground. All measures have been taken to keep the machine house as dry as possible.

Each of the larger turbines drives directly an alternating current machine of the type A7, which at 170 turns per minute generates a current of 42 ampères at 5,100 volts. The magnet wheel of the alternating current machine has the diameter of 2,200 mm., and possesses 30 poles.

Each of the small turbines drives (directly also) an exciter dynamo of the type VPV, which has four poles, and at 375 turns per minute produces a current of 180 volts and 150 ampères, each of which is amply sufficient to excite three alternating current machines.

All the journals are arranged for automatic lubrication.

Three travelling cranes have been set up in the machinery for elevating machinery and for facilitating any future repairs.

As the exciting machines are arranged parallel to each other (and also the alternating current machines), the superintendence of the working is very simple.

In the exciting circuit of each machine hand rheostats have been introduced. The regulation, properly speaking, is accomplished by two automatic rheostats—Blathy's patent—which act upon the exciting currents of the exciting machines and regulate the tension of the exciting current in such a manner that the tension of the alternating current at Rome is kept constant, the influence of the loss on conduction being compensated by an equaliser. The connection and disconnection of the alternating current machines takes place by means of a load resistance of iron wire, containing 140 kilometres of wire. This rheostat is divided in halves, each of which is subdivided into 16 divisions.

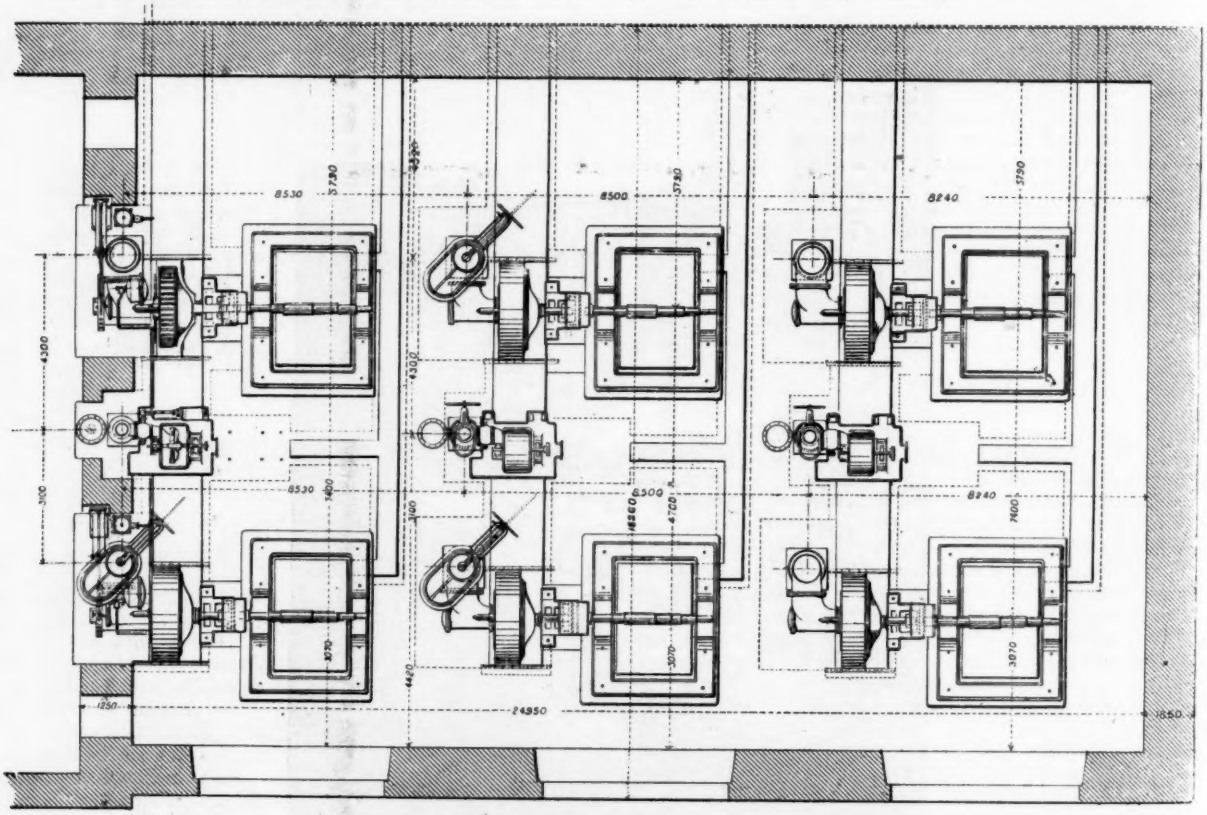
The connection and disconnection of the exciting machines takes place in the same manner, for which purpose a similar load resistance is set up. All possible connections, disconnections, and transpositions may be carried out without occasioning any visible change in the light.

At the switchboard a number of suitable ampèremeters and voltmeters are placed, so that the performance of each single machine can be accurately checked.

All the disconnectors consist of large jars of ebonite filled with mercury, into which plunge contact rods. By raising or lowering the jars with suitable levers, the connections or disconnections are effected.

The line from Tivoli to Rome passes nearly in a straight line across the dreary and forsaken Campagna Romana, a distance of 28 kilometres. It consists of four copper cables, each of 19 wires, of 2·6 millimetres, and having, therefore, a section of 100 square millimetres. The entire lead represents, therefore, a quantity of about 100 tons of copper.

The cables can be grouped at pleasure, which is very important if repairs become necessary.



PLAN OF STATION.

When five machines are working at their full load, the loss in conduction is 1,020 volts = 20 per cent.

Of these four lengths of cable now existing, three suffice for the full demand of the electric works, whilst two suffice for two-thirds of the normal full load. The existing conduction, arranged as just described, is in the fullest sense adequate for the utmost demands of secure working.

As the Campagna is a desert, very particular attention was paid to the conductive line, and exceptionally substantial constructions were chosen.

The cables are supported upon very strong oil insulators at distances of 35 to 40 metres.

The pillars consist of two "T" irons of 210 mm., placed side by side and bolted together. Into these pillars there are inserted above as continuations, beams each 3 metres in length, on which the insulator supports are secured.

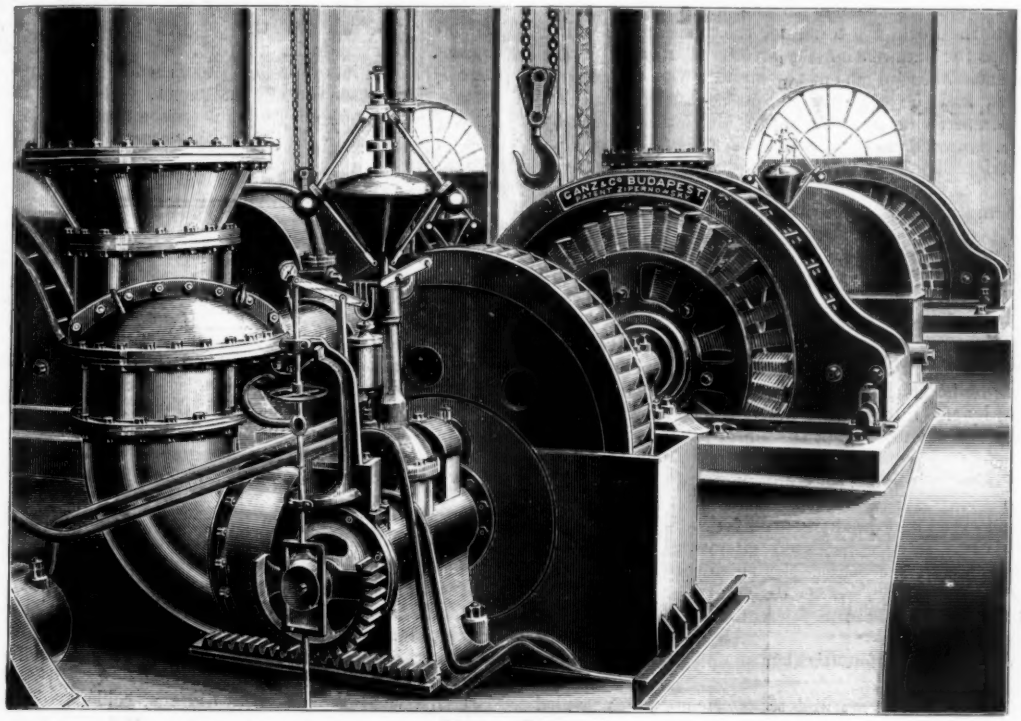
On the same pillars there are laid four silicon-bronze wires of 2 mm. in thickness, serving for telegraphic and telephonic purposes. The lowest wire is 7 metres above the ground.

The lead arriving from Tivoli ends before the Roman city

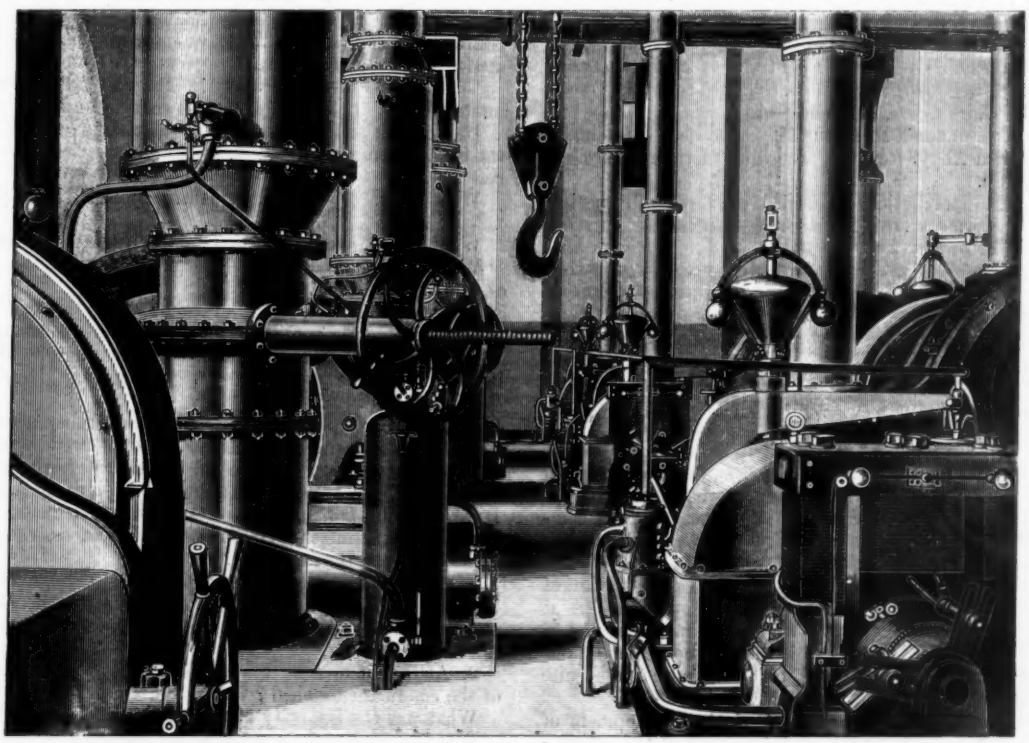
wall in a small building near the Porta Pia, in which are placed the necessary transformers and other apparatus.

As the electric installation now in operation at Rome works with a tension of 2,000 volts, and the Tivoli installation, as already mentioned is to serve as a supplement to the Roman electric works, the currents arriving from Tivoli at a tension of about 4,000 volts, must be in the first place converted into currents at about 2,000 volts. For this purpose 32 transformers have been placed in the lower storey of the above mentioned building, each of a nominal capacity of 25,000 watts. These apparatus are constructed with a converting proportion of 1 : 2, and hence the currents conveyed to the Porta Pia are converted from about 4,100 volts to approximately 2,000 volts.

Of the 32 transformers, each 16 connected primarily and secondarily parallel to each other, forming a group, transmit the 2,000 volt alternating current into the underground net of concentric cables which served for the general distribution of current in Rome. In particular, in summer, at the time of least consumption and altogether during the hours of day-



INTERIOR VIEW.



ANOTHER INTERIOR VIEW.

light, the service will be entirely effected from Tivoli and the steam central station will come into play only on occurrence of increased consumption. For this purpose the distribution tower (at the Porta Pia) was connected by special leads with the Cerchi steam central station, whilst, besides, a special underground net leads from the distribution tower into parts of the city not supplied by the Cerchi works.

A peculiar interest attaches to the distribution of the current from the Porta Pia tower for the purpose of feeding the arc-lamps for illuminating the streets of Rome. There are at present 250 installed, but the number with the present arrangement may be increased to 600. These lamps are introduced in series up to 45 each, and they are supplied by means of aerial leads of copper wire of 4 mm. The employment of aerial leads was imperative as these lamps are distributed over the whole extent of Rome, and an important part of them lies remote from the underground conductive net.

Of the large transformers in the tower each can give off 14 ampères at 2,000 volts, which is sufficient for supplying 45 powerful alternating current arc-lamps. Hence 14 such transformers can serve 14 circuits of arc-lamps (more than 600 lamps), whilst the two remaining act as reserves. In each of these circuits there is introduced an automatic rheostat which keeps the intensity of the current constant at 14 ampères by the introduction and removal of resistances on variations in the number of the lamps in use.

But in order to avoid great losses of work by the introduction of these resistances, the transformers above mentioned are wrapped in such a manner that with corresponding arrangements they may produce currents of 500, 1,000, 1,500 and 2,000 volts, and the necessary alterations can be easily and simply carried out whilst the apparatus is in action. Hence, it is possible by suitable distribution to the various circuits to reduce the losses in the regulating resistances to a minimum.

The arc lamps are differential lamps with a fixed luminous point and a low case.

All the machines, leads, and transformers, are provided with suitable lead fastenings and arrangements for protection against lightning.

In the central works at Tivoli, and at the distribution tower, there are complete arrangements for measurements and for gauging the insulation.

The total arrangement of the central and of the distributive tower, as well as the arc lamps taken into use, have been supplied by Ganz & Co., of Buda-pest.

The conductors and their supports have been constructed by the Società Anglo-Romana, according to the instructions of Ganz & Co.

The entire installation is carried out with alternating current transformers on the system of distributing currents devised by Zipernowsky-Déri-Blathy, and it presents this day, beyond question, the most important practical application of a distribution of electricity at a great distance. Experiments have been certainly in the meantime conducted at the Frankfurt Exhibition at great distances, and with the use of higher tensions. Still, these were merely temporary experiments of exclusively theoretical importance, whilst the electric works at Tivoli are destined for permanent industrial utilisation. It must be considered that this project was designed in 1888, consequently at a time when the use of currents of 5,000 volts were viewed as a quite unusual result.

What was thought of the project at that time appears from the report of Prof. Blaserna of Rome, who was commissioned by the Roman municipality to give in an opinion. He expressed himself as follows :—

"This is the most magnificent project of a conduction of electrical energy which yet exists in Europe. Hence it deserves, both on account of its own great importance and of the lustre and the advantages which it will confer upon our city, if it is successfully executed, to be submitted to a quite especial consideration."

After a brief historical retrospect of the development of the transmission of electricity, and especially of the alternating current transformer system, the author discusses the several technical details of the Tivoli project and after declaring that the alternating current, as compared with the continuous current, presents notable advantages whereby the service must be simpler, more rapid and more certain, he concludes his report as follows :—

"From a thorough examination of the project submitted by the Società Anglo-Romana, it appears to contain no single point which may not be already pronounced practically solved.

"It has been elaborated by the able electrical specialists of the company on the basis of the most modern results of science and in accord with the firm of Ganz & Co., who have at their disposal a staff of truly extraordinarily meritorious collaborateurs, whence the project guarantees a certain success. It exceeds in no part, not even in the slightest degree the limits of present experiments, and hence it presents a firm basis for our judgment. Hence it may as a whole be pronounced the most magnificent project which has yet appeared in this interesting region."

THE PHYSIOLOGICAL EFFECTS OF HIGH TENSION ELECTRIC CURRENTS.

PROFESSOR LACASSAGNE, of the Lyons *Faculté de Medicine*, is now carrying on jointly with Dr. Biraud an inquiry with a view to studying from a medical point of view the physiological effects of high tension electric currents.

With this object Dr. Lacassagne has drawn up a list of questions which we give below, and requests electricians and all who are in a position to give information on the subject to send answers to them. Of course, professional secrecy will be observed in the publication of all communications.

The questions are as follows :—

1. Has any member of the staff at the works been the victim of an accident through contact with a conductor ?

Was this accident fatal at once, or were the effects only slight ? What were the consequences ?

Under what circumstances did the accident take place ?

What part of the body came in contact with the wire ?

Did the two hands touch two conductors with different potentials ? Or did the discharge take place through the body, between the hands and the earth, the feet of the victim resting on damp soil ? What was the tension on the conductor at the point touched ?

Did the victim utter a cry ? Did he fall, or was he unable to leave hold ? Did he lose consciousness ?

Impressions at the moment of the discharge ; flashes before the eyes, buzzing in the ears, pricking sensations about the body, &c. ?

What measures were taken to restore him ? Was a doctor called ?

What effects followed the accident ? Burns ? Their seat ?

Was the victim burnt at any other point than the points of contact ?

Was the fainting of long duration ? Was the victim able to walk afterwards ? Were certain movements made with difficulty ? Was there difficulty in breathing ? Was he bent ? Had he pains in the muscles ? Headache ? Vertigo ? Nausea ?

Did these symptoms last long, and did they necessitate confinement to bed ? Was the accident followed by paralysis of the limbs or face ? Did it affect the understanding or the memory ? Was there any diminution of muscular power ? Did the victim fall into a state of weakness, characterised by loss of sleep, strength, and appetite, with excessive nervous excitability and sensitiveness ?

Were there after the accident any other derangements of the system that could be attributed to electricity ? Was the sight affected, or the hearing, feeling, muscular power &c. ?

2. At the moment of the accident, what was the potential of the conductor touched ?

What was the intensity of the current ?

Was it a continuous or alternating current ?

If the latter, what was the number of alternations per second at the average speed of the dynamo ?

Was the conductor a naked wire, or had it lost its insulating material ?

Did the current that caused the accident proceed directly from the dynamo, or had it passed through a transformer ?

As M. Emile Gautier says in the *Figaro*, the time has come for clearing up this dark and tragic problem, and for knowing exactly wherein the danger lies, and of what it consists.

The safety of all is involved, and it behoves us, for the sake of humanity, to draw up the statistics suggested by Prof. Lacassagne as completely and accurately as possible.

All communications on the subject to be addressed to Dr. Lacassagne, at the laboratory of the Faculté de Lyon, Quai Claude-Bernard, Lyons.—(*Revue Internationale de l'Electricité.*)

OVERHEAD WIRES.

COUNTY COUNCIL BYE-LAWS.

ON Wednesday, the 30th ult., a deputation from the Electrical Section of the London Chamber of Commerce waited upon Sir Courtenay Boyle for the purpose of making representations in reference to the bye-laws framed by the County Council for the regulation of overhead wires in and around London, under the powers of the London Overhead Wires Act of 1891.

Sir VINCENT KENNETT BARRINGTON said, in introducing the deputation, that the Electrical Section of the London Chamber of Commerce was one of the strongest trade sections of that body, and he believed that it fairly represented the great electrical industries of the Metropolis. Great anxiety had been felt by the industry about the question of overhead wires, and the deputation would, no doubt, have been stronger and would have had a more able representative of the council than himself to introduce it but for the fact that the Second Congress of Chambers of Commerce of the whole Empire was then proceeding. The object of the deputation was to make certain representations as to bye-laws which had been framed by the council for the regulation of overhead wires. They were aware that Government departments were now taking a far deeper interest in trade concerns than formerly, and they were aware that while doing so the interests of the public as a whole were considered, and rightly, as being paramount to the interests of any section of it. But they felt it was at least possible that in safeguarding those interests they (the Board of Trade) might inflict restrictions upon a great and growing industry which would impede its development without securing any appreciable decrease of any dangers that might exist in connection with the erection and maintenance of overhead wires. Major Flood Page, the chairman of the section, would be able to go into the details of the question. It was merely his duty as representing the Council of the London Chamber of Commerce to assure him (Sir Courtenay Boyle) that the deputation came to the Board of Trade with the entire concurrence and sympathy of that body.

Sir COURTENAY BOYLE in reply, said that it might be well, not that the Chamber of Commerce representatives should go into all the details which had led them to petition against the bye-laws, but that he should indicate the modifications which it was proposed to make as the result of a public inquiry. Before doing so, however, he would wish to point out, although he did not wish to press it too far, that that was a public inquiry at which the bodies interested were represented and at which it would have been convenient, if the London Chamber of Commerce had made it convenient, to be represented. It was a little irregular to hear *ex parte* statements from one side alone after the inquiry had closed, but owing to the exceptional position of the London Chamber of Commerce, the Board of Trade had decided that they should be heard.

MAJOR FLOOD PAGE gave what were evidently considered satisfactory reasons for the attitude taken by the Chamber of Commerce, and Sir Courtenay Boyle dealing with the clauses which had been petitioned against by that body, indicated the amendments which had been made by the Board of Trade, and which are as follows:—

The word "company," defined by the County Council as meaning "person," to be struck out, the use of the word being defined by the Act.

Instead of Clauses 1 and 2, a clause to be substituted to this effect:—That the company shall give to the County Council and to the local authority particulars of the material and gauge of the wires, nature and position of the supports and length of span, also a plan, at their option showing the routes of the wires, &c., or those details may be marked on a plan to be kept at the office of the council. As regards existing wires, this requirement must be conformed to within six months, and as regards future wires, within a month after their erection.

In Clause 4 it shall be stipulated that wires are not to be at a less height above the roof of any building than 6 feet, instead of 7 feet, as in the original bye-law.

Clause 5 required that wires shall be supported at intervals not exceeding 115 yards, but that by special permission of the council and local authority, it might be extended. It was in no case, however, to exceed 140 yards. This restriction is now struck out and the council and local authority may sanction a greater span than 140 yards.

Bye-law No. 6, requiring that the angle between the wire and the direction of the street shall be not less than 60°, to be struck out.

The new bye-law in place of No. 7 shall simply require all independent conductors and suspending wires to be securely attached to the supports, instead of requiring that they should be shackled off at each support.

Instead of requiring, as in Clause 8, that the factor of safety for all conductors and suspending wires should be *five*, and for other parts of the structure *ten*, it shall now be stipulated that the factor of safety shall be for the conductors at least *four*, at a temperature of 22 Fah., and for other parts *ten*, taking the maximum wind pressure against the support in a horizontal direction at 30 lbs. per square foot, instead of 50 lbs., as before provided.

The word "pole" in Clause 9 will not be substituted for support, as suggested by the London Chamber of Commerce, but the words, "Every new support for a wire shall also have the date of erection marked thereon," shall be struck out.

Clause 10 of the County Council Bye-Laws, provided that no support for a wire which carried more than 10 wires should be used for the wires of more than one company. The new bye-law will only require that when a support is used for the wires of more than one company, the company owning the supports shall be responsible for them and the attachments.

Clause 11, requiring that no single support should be used for more than 20 wires, to be struck out.

Clause 12 required that cables should be carried by independent suspending wires, and that no cable should exceed 1 inch outside diameter and 1 lb. per lineal yard in weight. The restriction as to the outside diameter will be removed in the new bye-law, and the limit of weight will be fixed at 1 lb. per lineal foot instead of 1 lb. per lineal yard.

Clause 14 stipulated that all poles should be carried on properly galvanised iron shoes and saddles and efficiently stayed, so that if a pole should break it should not fall into the street. It will now simply be provided that all poles, unless fixed through the roofs of buildings, shall be carried on shoes or saddles properly protected from oxidation.

Clause 15, requiring that all metal wires should be connected to earth, to be struck out.

By Clause 19, it was stipulated that no wire support or attachment should remain erected for more than one month after it had ceased to be in use by the company. Now it will be stipulated that no wire is to remain erected after ceasing to be in use, unless the company intend to take it into use again within a reasonable time, in which case notice of such intention must be given to the County Council and the local authority.

Under Clause 21 of the bye-laws, penalties are imposed for a violation of the bye-laws of the provisions of the Overhead Wires Act of 1891. The London Chamber of Commerce, in its petition, contended that the council or local authority had only power to impose penalties for a violation of its bye-laws, and not for non-compliance with the Act, but it was pointed out that the Act gave power to deal by means of the bye-laws with failure to comply with its provisions.

Coming to Clause 22, which requires that the companies shall secure the right of access to the officers of the council and local authority to any building for the purpose of inspection of the wires or supports, Sir Courtenay Boyle said he was afraid that the deputation would not be satisfied with the decision on that point. The question had received the most careful consideration at the hands of the Board of Trade, and the clause had been amended so as to require that reasonable notice should be given to the company by the council or local authority that inspection was to be made, but he was afraid more could not be promised. The point had been put before the President of the Board specially for his decision. The representations made on the subject by the representatives of the company, as well as those in the petition of the London Chamber of Commerce, had been specially brought under the notice of the President, but it had been decided that to leave out the principle of that clause would be to destroy the whole object and effect of the regulations.

MAJOR FLOOD PAGE regretted to hear such a decision had been arrived at upon so important a point. The evidence his committee had had before them was such as to show that even under the existing circumstances the difficulty of obtaining fresh way-leaves was enormous. The telephone service was at the present time admittedly bad, simply because the companies had not compulsory powers in reference to way-leaves. In contracting for fresh way-leaves, the companies would be bound to say that the wires were subject to inspection at any time by the County Council inspectors, and the result would certainly be that the way-leave would be refused. The danger was problematical, since out of 700,000 accidents in London, only two had been traced to overhead wires. He urged that the companies should only be required to do their best to obtain power of access to the officers of the council or local authority.

Sir COURTENAY BOYLE felt that he could not hold out any hope of any amendment being made, but, in deference to the wishes of the deputation, he agreed to again bring the matter before the President.

The deputation then thanked Sir Courtenay Boyle for his courteous reception, and withdrew.

LONDON COUNTY COUNCIL.

AT the two last meetings the adjourned report of the Highways Committee was as follows:—The consideration of the following paragraph (No. 1) of the report brought up to the Council on June 21st, was postponed—

Victoria Embankment—Lighting.

Our attention has been directed to the defective lighting of the Victoria Embankment, and especially of the carriageway, and for some time past we have had under consideration the desirability of substituting electricity for gas as the illuminant. In connection with this substitution the first question that presents itself is what method should be adopted to provide the supply of electrical energy; and

three courses appear to be open for adoption, viz., (*a*) to obtain the supply from the companies authorised to supply within the areas in which the embankment is situated; (*b*) for the council to lay the mains and provide and fix the lamps and then to obtain the supply from one of the companies; and (*c*) for the council to instal the necessary plant on its own land and to light the embankment by means of an independent installation. The first course (*a*) is open to the objection that three several companies would have to be dealt with, the City of London, the Metropolitan, and either the London or the Electricity Supply Corporation, and considerable complication might arise, as one part of the embankment might be efficiently supplied while others might not; and, moreover, as each company would have to lay mains for the portion within its own district, the cost might be increased. The second course (*b*) is open to the objection that although the council would provide the mains, and would not, apparently, be prohibited from carrying the current from one company's district to another, the other companies might consider that this course, although probably legal, was straining the strict interpretation of the Acts. The third course (*c*) appears to us to be the proper one for the council to take, having regard to all the circumstances. The first capital expenditure would, of course, be greater, but the cost of maintenance would probably be less; and the adoption of this course would accord with the principle which has been affirmed by the council, of the carrying out of work by its own staff when practicable. Should the council decide to adopt the electric light as the illuminant for the embankment, we propose that lamps of from 1,000 to 1,200 candle-power should be placed in the centre of the road at about 50 yards from each other. About 50 of these lamps would be required for the carriageway, some few of which at important points might be of a higher illuminating power; and the supply of the electric light might also be extended to the existing lamps on the parapet walls, and, where necessary, to those on the footways. The generating power required for this installation might conveniently be placed upon the land belonging to the council under the Charing Cross Railway bridge; and for the purpose of insuring against the extinction of the light through the failure of any part of the machinery, and also as an economical precaution, the light should be placed on two independent circuits, an engine and dynamo being provided for each circuit, and a third engine with dynamo being kept in reserve to be available, if required, for either circuit. Steam could be supplied by a boiler of the locomotive type, and a second boiler should be kept in reserve for use if required. The mains could be so arranged that at midnight, or at any other time that might be fixed for the purpose, the lamps on one circuit could be extinguished, leaving the Embankment less brilliantly and yet sufficiently lighted. Upon the question of cost, we are advised that the capital expenditure, if the above arrangement were adopted, would probably not exceed £10,000, while the cost of maintenance, including depreciation, repair, and interest on capital, and also providing amply for labour, would probably not exceed £2,000 per annum. It may be stated that, with a comparatively small increase on the capital expenditure above stated, provision might be made for the lighting of the Embankment Gardens and the Westminster and Waterloo Bridges; but this is a matter which could afterwards be dealt with by the committees concerned. After full and careful consideration of the facts, and of estimates put before us by the council's officers, we have come to the conclusion that it is desirable that the electric light should be adopted as the illuminant for the Victoria Embankment, and that the council should itself undertake the work in connection therewith. We accordingly recommend that, subject to an estimate being submitted to the council by the Finance Committee as required by the statute, it be referred to the Highways Committee to carry out, at a cost not exceeding £10,000, an electric installation with the necessary plant for the lighting of the carriageway, footways, and parapet wall of the Victoria Embankment.

Electric Lighting Acts and Orders.

Camberwell and Wandsworth Orders, 1891.

The Board of Trade has intimated that the undertakers under these orders have failed to satisfy the board that they are in a position to discharge the duties and obligations imposed upon them by their respective orders, and that the board proposes, subject to any observations of the council or the local authority, to revoke the orders. We have directed that the Board of Trade be informed that the council has no observations to offer with reference to the matter; and we recommend that our action be approved.

Notices under Electric Lighting Acts and Orders.

A notice, dated 25th June, 1892, has been given by the Electricity Supply Corporation, of intention to lay mains across Panton Street, and along the footway on the west side of Oxendon Street, and across that street opposite the Prince of Wales's Theatre. The proposed works are of the usual character; and we recommend that the sanction of the council be given to the works referred to in the notice, dated 25th June, 1892, of the Electricity Supply Corporation, upon condition that the company do give two days' notice to the council's chief engineer before commencing the work; that the concrete floor of the road boxes shall be 9 inches thick, and the York stone on the top 4 inches thick; that the brickwork of the boxes shall be 9 inches thick; and that the longitudinal girders on all the boxes shall be laid in 3-inch stone templates the full thickness of the brickwork.

We have also to report the receipt of the undermentioned notices, given in accordance with the resolution of the council to accept four days' (instead of one month's) notice in respect of the laying of service lines from mains already laid:—

From the St. James and Pall Mall Electric Light Company—June 17th, 1892, to 26 and 28, King Street, St. James's Square; June 27th, 1892, to 115 and 115A, Regent Street; June 30th, to 210 and 210A, Regent Street.

From the Kensington and Knightsbridge Electric Lighting Company—June 17th, 1892, to 5, Montpelier Terrace.

From the House-to-House Electric Light Supply Company—June 18th, 1892, to 25, Harrington Gardens; 39, Rosary Gardens; June 22nd, 1892, to 19, Wetherby Gardens; 10, Gledhow Gardens; 5, Priory Grove; June 23rd, 1892, to 27, Trebovir Road; June 24th, 1892, to 36, Cranley Gardens.

From the Notting Hill Electric Light Company—June 22nd, 1892, to 72, Holland Park; 43 and 45, Notting Hill Gate.

From the Westminster Electric Supply Corporation—June 28th, 1892, to 81 and 87, Park Street.

REPORT OF THE ASYLUMS COMMITTEE.

Claybury Asylum Electric Lighting.

We have to report that tenders for the above works have been invited in accordance with the resolutions of the council of June 21st and 28th, and will be opened on the 26th inst. As this will probably be the date of the last meeting of the council before the recess, we propose that we should hold a meeting, or meetings, during the recess for the purpose of considering these and other tenders. We recommend that we be authorised to consider during the recess tenders which will be opened by the council on the 26th inst. for electric lighting of Claybury Asylum, and to accept one, if in our opinion suitable, subject to our reporting our decision hereafter.

NOTES.

Obituary—Mr. Cyrus Field.—The closing scenes in a remarkable life took place on Tuesday last, when Mr. Cyrus Field after a long illness, passed away. After a successful career in commerce, Mr. Field became deeply interested in the proposal to lay a cable from Newfoundland to Ireland, all the more as he was assured by some of the highest scientific authorities that the scheme was perfectly practicable, others, however, declaring a submarine telegraph from England to America to be an absolute impossibility. From 1854 to 1866 he devoted himself almost entirely to this single project. In March of the former year he went to St. John's, and obtained from the Newfoundland Legislature a charter granting him an exclusive right for 50 years to establish a telegraph line from the mainland to Newfoundland, and thence to Europe. Estimating the required expenditure at $1,500,000, he set to work to obtain that sum in New York, and after considerable difficulty, he was successful in doing so. The actual cost of the line, which was 2,600 miles long, was $1,834,500, or $334,500 in excess of Mr. Field's estimate. This line was a failure, and although another was laid in the following year, it, too, failed, and a sceptical public began to think that Field's scheme had now received its quietus, and that no more attempts to perform seeming impossibilities would be made. For seven years, indeed, this was the case, owing to the civil war; but Mr. Field never doubted the feasibility of his project, and in 1865 he again commenced the campaign. Naturally, during the lapse of time considerable improvements had been made in submarine telegraphy, the manufacture of the cable was better understood, and a superior machine for laying it had been constructed. The vessel selected for laying the line was the famous *Great Eastern*, which accomplished the task for a distance of 1,200 miles, when she lurched heavily, and broke the cable, all attempts to grapple it proving unsuccessful. The great scheme, however, was at last brought to a brilliant conclusion, and in 1866 Mr. Field received such honours as are seldom given to a private citizen. It was largely—indeed, almost entirely—to the indomitable energy of Cyrus Field, which gained for him the *soubriquet* of a "locomotive in trousers," that the world owed the success of the Atlantic submarine cable. Incredulity, strenuous opposition, ridicule, and indifference were all brought to bear upon him and his scheme, and he carried it through all; and it is said that during the various operations necessary to the realisation of the scheme he had crossed the Atlantic more than fifty times. He received the unanimous thanks of Congress, with a gold medal, in commemoration of his successful enterprise, and he also received the grand medal of the Paris Exhibition.

Transformer Tests: A Correction.—In the report of Dr. Hopkinson on the Westinghouse transformer, published in our issue of July 1st, an error occurred in the last paragraph but one, namely, the efficiency of the transformer at quarter load should read: "over 92 per cent.," instead of "84·7 per cent."

War Balloon Experiments.—A series of experiments to show the working of the Bruce electrical war balloon with flashing signals, by means of Mr. E. S. Bruce's recently improved electrical apparatus, was carried out at Stamford Bridge last week. The improvements which have been made mainly consist in the reduction of weight in almost every portion of the apparatus, so as to increase its portability and efficiency, the balloon being made of a much lighter material than when first exhibited.

Electric Wires and Cables in Italy.—The export of electrical wires (covered) from Italy is not so great this year as it was last. The quantities exported during the first four months of the present year are only 6 quintals, as compared with 174 quintals in the same period of last year. As regards the imports, the quantity of electric wires (covered) imported remains about the same, while the imports of submarine cables, &c., have greatly fallen off. During the first four months of the present year, Italy imported 18 quintals of electrical wires (covered) and 12 quintals of submarine cables, as compared with 19 and 1,502 quintals respectively in the same period of last year.

The History of Telephone Enterprise in Belgium.—Mr. Conyngham Greene, of the British Legation in Brussels, has lately written a report on the history and progress of telephone enterprise in Belgium, from which it appears that up to 1883 the telephone service in that country was in the hands of private companies, and the uncertain character of the concessions granted by the State checked the free expansion of private enterprise. Between 1880 and 1883 three separate telephone systems were in operation in Brussels, but, owing to competition and the refusal of the companies which worked the lines to grant mutual subscriptions over the lines of their rivals, no great success was obtained by any of them. In 1883 the State Department of Posts and Telegraphs took the initiative in organising and developing the telephone system of the country. A law was then passed authorising the Government to undertake themselves, or to concede on fixed conditions to others, the establishment and development of telephone lines. The uncertain and temporary character of the previous concessions gave place to a certain and regular system, and the effect was immediate. In a few months the Bell Telephone Company bought up the two rival companies of Brussels and secured a concession not only for the capital itself, but also for Ghent, Antwerp, Verviers, and Charleroi. The company started with a paid-up capital of £105,400, of which more than two-thirds was devoted to buying up the rival plant and apparatus and replacing that which was worn out and inefficient. The existing wires were replaced by phosphor-bronze wires on the Montefiore system. Owing to the superior capability of this wire for bearing a strain, it was found possible to diminish the number of supports, and thus to get rid of much useless material. Moreover, the expense of repairing the wires was materially reduced, as breakages were of very rare occurrence, and the interruption of the service proportionally unusual. By way of dividend, the company distributed in 1889 among its shareholders £10,750, and £15,181 in the following year, while the number of subscribers rose from 4,051 on December 31st, 1888, to 4,726 in 1892. The State has also laid and worked lines of its own to the less important centres, which were somewhat neglected by the companies. A system of receiving and transmitting telegrams by telephone to subscribers has been introduced, and has proved a great success. At present, the repurchase of all the telephone concessions by the State is impending, and will probably take effect from January 1st next, when a further large extension of the telephone system will take place. The Belgian experience is that the telegraph and the telephone do not injure each other, but that both systems must be in the same hands to enable the universal extension of the telephone system to pay. It appears, however, that in regard to Press messages between Paris and Brussels the telephone has wholly supplanted the telegraph, and the same is true to a large extent of Press messages generally. The head of the Technical Department of the Belgian Telegraph and Telephone Services stated the principle of successful administration to Mr. Greene in these words :—"The telegraph and telephone service must be one great monopoly, and that monopoly must be in the hands of the State."

Proposed Electric Lighting at Kingston.—A sub-committee of the Kingston Town Council, after visiting St. Pancras electric lighting station and obtaining information from Bradford, decided in favour of the council becoming suppliers of the electric light. At the last meeting of the Town Council it was resolved to ask for schemes from engineers and electrical companies.

Dundee and Electric Lighting.—At the monthly meeting of the Dundee Gas Commission, held on July 6th, it was reported that all the contracts for the proposed electric works had been prepared and sent out for execution, with the exception of a small section of the works, on which some alterations were to be made. One contract had been returned executed. In answer to a question, the Chairman said the price of the electric light had not been fixed, but he believed it would be about 6d. per unit. The Board of Trade have approved of the scheme.

Stone v. the Metropolitan Electric Supply Company.—On Thursday, July 7th, at the Bloomsbury County Court, his Honour, Judge Bacon, heard this case, which was a claim for one week's wages in lieu of notice. Although the case in itself is unimportant, the issue is not without interest to electric light companies. The plaintiff is a stoker, and said that he was engaged by Mr. Allborough, the superintendent of the company, on trial, and subsequently taken on the staff at 30s. 4d. per week of seven watches. He was a union man, and as there was some trouble with union men on the works, he was discharged along with others, on Monday, May 2nd. He was only paid for one watch, although he asked for a week's wages in lieu of notice. He had since been unable to get employment in London owing to the "row," and he now brought this action as much to vindicate his character as to recover the money due to him. The defence was that it was customary for companies to dismiss stokers on a watch notice, or to pay them for a watch. His honour said that he thought that in such work as this electric supply, where anything like a strike or sudden caprice on the part of the men might cause injury to employers, it was not unreasonable that the men should be liable to dismissal at the termination of one period for which they receive their wages. He (the learned judge) was satisfied that this man was employed by the eight hours, and was not entitled to a week's notice. Judgment for the defendant company.

The Electric Light at Barnsley.—After much discussion, it appears that the electric light may after all be supplied by the Town Council. It will no doubt be remembered that the Westinghouse Company submitted a scheme for lighting the town at an estimated cost of £33,000. The Borough Surveyor has now placed before the council two schemes of his own, the first for a nominal output of 2,500 8-C.P. lamps, and 28 1,200-C.P. arc lamps for street lighting, with two miles 93 yards of mains and feeders laid under ground; and the second, for a nominal output of 5,000 8-C.P. lamps, and 31 1,200-C.P. arc lamps, with 2½ miles of mains and feeders laid underground. The area of scheme No. 1 is 45, and No. 2 60 acres, containing eight dwelling houses, of more than £20 a year each value; 252 shops, &c. 11 mills, workshops, chapels, &c. He believed the council may rely on having consumers for 2,500 8-C.P. lamps within twelve months, especially as the Harvey Institute would require 1,000 such lights. A central lighting station might be provided at Messrs. Robinson's timber yard, or at Beckett Square. The low tension continuous current supply is recommended. The scheme would cost £18,382. The working cost, allowing for interest and sinking fund, is estimated at £2,859 14s., and the revenue £4,288 12s., showing a net profit of £1,428 18s. Scheme No. 1, with half the number of 8 C.P. lamps, shows working cost, £2,036; revenue, £2,217 8s.; profit, £181 6s. The Park and Lighting Committee add a further report, and recommend: "That the electric light be installed on a site in Beckett Square, at an estimated cost of £18,382, but that at present only £13,332 be expended; that Mr. A. Bromley Holmes be the electrical engineer; that the Borough Surveyor prepare plans of buildings, &c.; and that application be made by the council to the Local Government Board for their sanction to borrow the said sum of £18,382."

Leith Dock Commission and the Electric Light.—A proposal is under the consideration of the commission to light the docks by electricity, the estimated cost of the installation being £10,000.

The Decision in the Hydrocarbon Lamp Suit.—Judge Acheson in the United States court at Trenton, N.J., has given his decision in the case of the United States Electric Light Company *v.* Edison Lamp Company. The issue was the right to use the carbon process, and in a lengthy judgment the judge found for the defendant. The suit was brought by the plaintiff for infringement of letters patent dated October 21st 1884, granted to Edward Weston, which invention claimed an improvement in making carbon conductors for incandescent lamps. It consisted in forming a carbon core and depositing on this during an electrical heating process, carbonaceous substance. The defence claimed that this patent was anticipated by a Sawyer-Man patent of 1879, and that there was a public use for two years prior to Weston's application for a patent. The judgment stated that the evidence of the plaintiff was vague. In the language of the judge, "How can Weston's assertion that from about the middle of the year 1877 he saw that he had overcome all troubles relating to the preparation of carbon for incandescent plants be satisfactorily reconciled with his subsequent conduct: his silence as to an invention then deemed so important? His great delay in applying for a patent for the process is more extraordinary when we discover from the proof that in the years 1878 and 1879 he took out and applied for no less than ten patents for various other inventions. Furthermore, it is a significant fact that when Weston eventually moved on May 27th, 1881, his application for a patent was made in the interest of the plaintiff company, as assignee, after the plaintiff had failed in its negotiation to purchase the Sawyer and Man patent or to acquire a license under the same." The public use of the invention for two years was established. For the foregoing reasons and others not referred to, the complaint was dismissed.

The Physiological Effects of Alternating Currents of High Frequency.—A very interesting communication on this subject was recently made to the Electrical Section of the Franklin Institute by Prof. E. J. Houston. A "principal cause why discharges of enormously high frequency of alternation should be so comparatively harmless," he suggests may be found in the application of "the modern ideas of how an electric discharge is believed to pass through a conducting path or circuit" to the human body. He defines "the modern idea" as that which supposes the energy of alternating currents to sink or soak from the surface of a conductor towards the centre only while the impulse continues, and when the direction of the impulse changes it moves in the opposite direction and towards the surface. From this it follows that "in the case of alternations of very high frequency, the central portions of the conductor are entirely free from electric currents, the current being limited to the portions near the surface." If we may regard the human body as sufficiently like an ordinary conductor, this seems in one way a very possible explanation of the harmlessness of such currents. It is unfortunate, however, that the Professor does not give us some idea as to how far the effect of the same current strength at different frequencies has been taken into account. In Tesla's experiments (upon observations connected with which Prof. Houston apparently bases his paper), we thought the main cause of the harmlessness of the currents used lay in the fact that they were transformed up till voltage became everything and the ampèreage practically nothing. If it can be shown that by the mere increase of frequency when E.M.F. and strength of current remain the same, the possible harmful effects upon the human body are eliminated, the conclusions of Prof. Houston are thoroughly justified, but there is nothing to indicate this in the paper before us. We think, therefore, that the worthy professor was slightly romancing in his final statement, which runs as follows: "If these views are correct, it would appear that when the human body is exposed to rapidly alternating discharges, it is subjected at one moment to a discharge that might produce instant death, were it not for the fact that the bolt is practically no sooner hurled at the body than it is hurled away from it." Of course this may be, but the evidence of it is not yet forthcoming.

Burton-on-Trent Lighting.—Last week the gas committee of the town council reported progress in the project for introducing electric light.

Telephones in Austria.—The Vienna Private Telegraphs Company is paying a dividend of 8 per cent. for last year, the same as for 1890. Negotiations are approaching completion whereby the Government will take over the company's system.

Electric Light for East Moulsey.—A company has been formed for the electric lighting of this village. The Local Board at its last meeting discussed a report from its General Purposes Committee suggesting that the Board should decide whether the new company would be required to light all the public lamps in the village and whether some practical electrician should be called in to give the board advice on the scheme. No action was taken, however.

Bristol Electric Light Preparations.—The Bristol Electric Light Committee have considered tenders for the condensing plant in connection with the installation which is expected to be inaugurated about Christmas. There were five tenders, and the committee resolved to forward them to Mr. Preece, their electrician, with a request that he would report to them with any suggestion he had to make. The tender of the Boiler Insurance and Steam Power Company, Limited, for the insurance of the boilers for the electric light stations, was accepted.

Electric Lighting in the Paisley Burgh.—The electric lighting committee having resolved at a former meeting to call in the assistance of Mr. W. A. Bryson, electrical engineer, Glasgow, arranged that he should obtain estimates from three low tension and three high tension contractors of the cost of putting down an installation sufficient to light the compulsory area of supply under the order. Since then tenders had been submitted from five contractors, ranging in amount from £33,000 to £22,550. The committee are now obtaining further details of cost, and will no doubt shortly report.

Guildford Urban Sanitary Authority and Mr. Shoolbred.—On the subject of electric lighting, the committee wished the authority to decide whether they should obtain the opinion of another engineer beside Mr. Shoolbred, or whether they should accept Mr. Shoolbred's offer to have a personal interview with the council on his report. Mr. Salsbury suggested that they should not take any further action at present. Mr. Shoolbred's report was, in his opinion, not worth the paper it was written on, but if Mr. Shoolbred was willing to interview them without further fee, there could be no objection to their receiving them. He himself was doing his best to obtain information on the matter, and he hoped others would do the same. Mr. Colebrook, as largely responsible for the committee's report, endorsed what Mr. Salsbury had said about the inadequacy of Mr. Shoolbred's report, and the desirability of interviewing that gentlemen if he would come without further fee. At the same time, though, of course, he did not advocate hurry, he did not want the matter to drag on for two or three years. Mr. Cable said that it was only fair to Mr. Shoolbred that he should be allowed to supplement his report as he had offered to do. Mr. Allen said that they would have to pay Mr. Shoolbred £25, and they ought to have value for their money. They need not even be tied to Mr. Shoolbred then. The report as it stood was of too vague a character for them to act upon it. The mayor thought they needed some practical electrician to guide them in their interview with Mr. Shoolbred. Alderman Bullen endorsed this view. Mr. Shoolbred, he thought, was only a consulting engineer, and his report needed to be supplemented by one from a practical engineer. In the course of the discussion four propositions were made. 1. That Mr. Salsbury's name should be added to the committee. 2. That Mr. Shoolbred's report should be printed and circulated. 3. That the whole board interview Mr. Shoolbred. 4. That the committee should prepare questions to be put to Mr. Shoolbred at the interview. It was ultimately agreed that the report from Mr. Shoolbred should be printed and circulated, with a view to further action by the committee.

The Sale of Provisional Orders.—The Chiswick Local Board are handing over their electric light order for 21 years to Messrs. John Bourne and Thomas Barnet Grant for the sum of £600.

Institution of Mechanical Engineers.—The annual conference is to be held at Portsmouth this year, and among the papers to be read is one by Mr. Henry E. Deadman, chief constructor, of Portsmouth Dockyard, on the applications of electricity in the Royal Dockyards and Navy.

The Fire in Newfoundland.—In the disastrous fire which occurred last Friday at St. Johns, the telegraphs suffered much. The telegraph office was destroyed and the wires damaged to a heavy extent, which caused great delay in the despatch of intelligence of the disaster.

A Small Strike.—About 30 labourers who have been employed in laying electric light cables in Exeter struck work last week for an extra halfpenny per hour. They had been receiving four-pence. The City Surveyor, who has been carrying out the work, put on the Corporation *employés*. The men gave no intimation whatever of what they intended to do.

Epstein Accumulators.—That these are making steady progress is evinced by the fact that the Birmingham Central Tramways Company have just placed an order for 600 Epstein cells with the Midlands branch of Messrs. Woodhouse & Rawson, United, at the Minories, Birmingham, the cells being for use upon the company's important electric car route in that city.

NEW COMPANIES REGISTERED.

Railway Electric Reading Lamp Company, Limited.—Capital £100,000 in £5 shares, to purchase from the Railway Automatic Electric Light Syndicate, Limited, the patents for the United Kingdom for Electric Reading Lamps, granted to D. H. Davies and J. M. Tourtel; to enter into an agreement to be made between the said syndicate of the first part, Messrs. Davies and Tourtel of the second part, and the company of the third part, to take over the benefits and obligations of an agreement, dated 27th May, 1892, between the Metropolitan District Railway Company of the one part, and the said syndicate of the other part, to enter into an agreement with the Metropolitan District Railway Company for an authorisation to instal and work automatic electric reading lamps in carriages of the said railway company; and to manufacture and deal in automatic electric reading lamps. Signatories (with one share each), B. H. Van Tromp, 4, Hyde Park Terrace, W.; E. Garcke, 1, Great Winchester Street, E.C.; S. Etlinger, 27, Cavendish Road West, St. John's Wood; W. H. Fox, 9, Austin Friars, E.C.; J. C. Bull, 1, Great Winchester Street, E.C.; J. M. Tourtel, 558, Mansion House Chambers, E.C.; F. C. Cocking, 192, Friern Road, Dulwich. The number of directors is not to be less than three nor more than seven, the first being E. Etlinger, J. H. Kincaid, C. E. Spagnoletti, and B. H. Van Tromp. Qualification, £50 shares. Remuneration, £800 per annum, divided between them, and a percentage of the profits. Registered on the 4th inst. by Jordan and Sons, 120, Chancery Lane, W.C. Registered office, 1, Great Winchester Street, London, E.C.

Hope-Jones Electric Organ Company, Limited.—Capital £25,000, in £10 shares (1,200 preferred and 1,300 ordinary). Objects: To enter into an agreement, dated 30th ult., between Robert Hope-Jones of the one part, and F. B. Townsend (for the company) of the other part, for the acquisition of certain letters patent, inventions, &c., to apply electric and pneumatic action to organs and other musical instruments, and to carry on the business of organ builders and electricians. Signatories (with 1 share each), R. S. Blease, Fenwich Chambers, Liverpool; P. M. Hunter, 15, Brown's Buildings, Liverpool; W. D. Hall, 73, Upper Parliament Street, Liverpool; W. H. Hunt, 35, Beresford Street, Oxton, Birkenhead; A. Grierson, 71, Lord Street, Liverpool; R. Hope-Jones (electrician and engineer), 55, Argyle Street, Birkenhead; E. T. Driffield, 26, Castle Street, Liverpool. The number of directors is not to be less than three, nor more than five, the first being T. Threlfall, G. A. W. Beard, W. D. Hall, W. Creser, and Robert Hope-Jones. Qualification, £100. Remuneration, £25 each per annum after the payment of a 6 per cent. dividend on the preference shares, and an extra £25 each per annum after the payment of a similar dividend on the ordinary shares, the chairman to receive an extra £50 per annum. Registered on the 1st inst. by Linklater & Co., 2, Bond Court, Walbrook, E.C. Registered office, 4, Huggin Lane, Queen Victoria Street, E.C.

Holloway Electricity Supply Company, Limited.—Capital, £2,000 in £10 shares. Objects: To purchase, take on lease, or otherwise acquire, and to establish and maintain central and other stations from which electricity may be supplied, and to carry on in the parish of Islington and elsewhere the business of electric lighting in all its branches. Signatories (with 1 share each): S. Sharp and J. M. Kent, 34, Victoria Street, S.W.; E. J. Piper, 4, Tollington Road, Holloway; P. W. Rands, 5, Boswell Road, Croydon; C. P. Heap, 60, Waldegrave Park, Strawberry Hill; H. A. Folkard, 9, Ormiston Road, Uxbridge Road, W.; G. H. Harrow, 4, Lonsdale Square, Barnsbury, N. The directors may acquire the business of a central electric lighting station, and that of electrical engineers and contractors carried on by Messrs. Sharp and Kent at Tollington Road and elsewhere in the parish of St. Mary, Islington. The number of directors is not to be less than three nor more than seven. Qualification, £500; remuneration as the company in general meeting determine. Registered on the 30th ult. by W. Sharp, 13, Walbrook, E.C.

Electric Lamp Company, Limited.—Capital, £4,000 in £1 shares. Objects: To carry on the business of an electric light company in all its branches, electricians, electrical and mechanical engineers, suppliers of electricity, and manufacturers of electrical and scientific apparatus. Signatories (with 1 share each): J. A. White, 38, Holborn Viaduct, E.C.; F. E. Pearl, 27, Ivanhoe Road, Denmark Park, S.E.; E. J. de Burriatte, 38, Holborn Viaduct, E.C.; W. J. Sorrell, 28, Taunton Road, Bermondsey, S.E.; A. Essinger, 28, Thavies Inn, Holborn Circus; J. N. Nyburg, 17, Hanway Street, W.; M. G. Alexander, 16, Hatton Garden. Registered (without articles of association) on the 28th ult. by H. W. Christmas, 42A, Bloomsbury Square, W.C.

London Electric Manufacturing Company, Limited.—Capital £10,000, in £1 shares. Objects: To carry on the business of electrical engineers, electricians, engineers and contractors, suppliers of electricity, manufacturers of electrical apparatus, chemical engineers, &c. Signatories (with one share each): R. T. Harrison, 1, St. John's Terrace, Highbury Park, N.; G. Shaw, 39, Waddon Old Road, Croydon; F. Day, 55, Tubbs Road, Harlesden; W. G. F. Hunt, R.N., Mickleham, Dorking, Surrey; A. B. Coombs, 57, Clarendon Road, Walthamstow; J. S. Hooper, R.N., 11, Comeragh Road, West Kensington, W.; A. Barrenger, 40, Wightman Road, Harringay, N. The regulations of Table A mainly apply. Registered on the 24th ult. by Sydney Morse, solicitor, 4, Fenchurch Avenue, London, E.C.

J. C. Howell, Limited.—Capital £25,000 in £5 shares. Objects: To acquire and carry on the business of electric light engineer, carried on by John C. Howell, at New Dock, Llanelly, Carmarthen, and 24, Queen Victoria Street, E.C.; to generate, accumulate, distribute, and supply electricity, magnetism, &c. Signatories (with one share each, J. C. Howell, Llanelly, electrical engineer; W. M. Meredith, Dorking; H. C. Cornish, Llanelly; T. H. Lewin, Parkhurst, Dorking; P. C. Scrutton, 24, Queen Victioria Street, E.C. (electrical engineer); H. B. Porter, The Hollies, Finchley; W. Eacott, 29, Powell Road, Clapton, N.E. The number of directors is not to be less than three nor more than seven, the first being J. C. Howell and W. M. Meredith, who are managing directors for five years. Remuneration J. C. Howell, £800 per annum; W. M. Meredith, £300 per annum, to be increased by £50 per annum. Registered on the 9th inst. by Deacon, Gibson & Medcalf, 4, St. Mary Axe, E.C.

Lithanode and General Electric Company, Limited.—Capital, £100,000 in £1 shares. Objects: To enter into an agreement with the Mining and General Electric Lamp

Company, Limited, and its liquidator, to carry on the business of an electric light, gas, and other light company in all its branches; to construct, lay down, establish, fix, and carry out all necessary mains, reservoirs, cables, wires, lines, accumulators, lamps, machinery, and works; and to carry on the business of electricians, mechanical engineers, gas engineers, lamp manufacturers, manufacturing chemists, suppliers of electricity, and manufacturers of electrical apparatus. Signatories (with one share each), J. E. Huxtable, 14, St. Helen's Place, E.C.; C. H. B. Ince, 102, Alexandra Road, South Hampstead; L. Mossop, B.A., 7, Combalt Road, Putney; C. R. Pearson, 2, Balfour Terrace, High Road, Leytonstone; J. E. Wood, 10, Placquett Road, East Dulwich; A. C. Crane, 3, Wood Lane, Highgate; J. A. Gedge, 14, Abbeville Road, South Clapham Park, S.W. The number of directors is not to be less than three nor more than nine, the first to be nominated by the subscribers to the memorandum of association. Qualification, £500. Remuneration: chairman, £150 per annum; ordinary directors, £100 per annum, and 10 per cent. of all profits after the payment of a 15 per cent. dividend, to be divided as they themselves determine. Registered on the 8th inst. by Paine, Son, and Pollock, 14, St. Helen's Place, London, E.C.

Richmond (Surrey) Electric Light and Power Company, Limited.—Capital £50,000 in £5 shares. Objects: to carry out the terms of the Richmond (Surrey) Electric Lighting Order, 1883, in accordance with a contract dated December 8th, 1891, between the Corporation of the Borough of Richmond of the one part, and Latimer Clark, Muirhead, and Co., Limited, of the other part; to enter into an agreement with Messrs. Latimer Clark for the purpose of having assigned to them the benefit of the contract dated December 8th, 1891, and to carry on the business of an electric light and power company in the municipal borough of Richmond. Signatories (with one share each) W. E. Grigsby, 7, King's Bench Walk, Temple; Sir Edward Hertslet, C.B., Belle vue House, Richmond; D. B. Hall, Heywood, Maidenhead, Berks; R. L. Kidd, Kewfoot Road, Richmond; J. Soares, Richmond; F. B. Alston, 69, Eccleston Square; E. C. Curtis, 15, Cranley Place, S.W. The number of directors is not to be less than three nor more than seven, the first to be appointed by the subscribers. Qualification, £200. Remuneration, £600 per annum divided between them. Registered on the 8th inst. by Lumley and Lumley, 37, Conduit Street, Bond Street, W.

Woodhall Spa Sanatorium, Limited. — Capital, £10,000 in £1 shares. Objects: to carry on the business of bath house keepers, hotel and restaurant proprietors, wine and spirit merchants, &c.; to construct and maintain electric lighting works; to generate, accumulate, distribute and supply electricity and other power. Signatories (with one share each) J. E. Allen, 8, Coleherne Road, South Kensington; O. Cromwell, Chislehurst, Kent; A. Montefiore, 1, Marlboro' Road, Bedford Park, W.; Hon. F. G. G. Osborne, Windsor; J. C. Walter, Langton Rectory, Horncastle, Lincolnshire; J. Heath, 67 and 69, Chancery Lane, W.C.; E. W. Lloyd, 1, Great George Street, S.W.; and 19 others. The regulations of Table A in the first schedule of the Companies Act, 1862, mainly apply to this company. Registered on the 7th inst. by Winser, Sykes & Co., 67 and 69, Chancery Lane, W.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Blockley Electric Lighting and Manufacturing Company, Limited.—The annual return of this company made up to the 13th ult. was filed on the following day. The nominal capital is £20,000 in £5 shares. 461 ordinary, and 67 £5 per cent. preference shares have been taken up and the full amount called. The calls paid amount to £2,640. Registered office, Blockley, Worcestershire.

Evered & Company, Limited.—The annual return of this company, made up to April 14th, was filed on the 3rd ult. The nominal capital is £200,000 in £10 shares; 16,496 shares have been taken up, and upon 6,744 of these the full amount has been called, and upon the remainder £7 per share has been called. The calls paid amount to £135,704. Registered office, 28 and 29, Drury Lane, London.

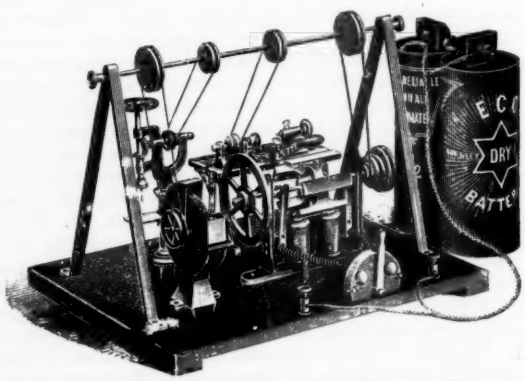
Greenwood & Batley, Limited.—The annual return of this company, made up to the 24th ult, was filed on the 30th following. The nominal capital is £400,000, divided into 14,000 preference and 26,000 ordinary shares of £10 each. 11,066 preference and 18,052 ordinary have been taken up, of which 2,666 preference and 4,666 ordinary have been issued as fully paid. Upon 1,466 preference and 1,252 ordinary shares £3 per share has been called, and upon the remainder the full amount has been called. The calls paid amount to £198,834. Registered office, 16, Great George Street, Westminster, S.W.

Regent Portable Electric Lamp and Lighting Company, Limited.—This company has been dissolved under Clause 7 (4) of the Companies' Act, 1880 (43 Vic. ch. 19) by notice in the *London Gazette* dated June 21st, 1892.

Water Primary Battery Company, Limited.—In consequence of the failure of this company to comply with the regulations, and since they have given no answer to repeated inquiries, it has just been dissolved by notice in the *London Gazette*, dated June 21st, 1892.

BUSINESS NOTICES, &c.

Novelties.—The General Electric Company, Limited, have just designed what they term an electrically perfect china electric bell push. It is made of Porcelain throughout, and has all its working parts mounted on Porcelain bases. This being a non-conducting plate the springs cannot rust nor short circuit. The advantage of this push over the old-fashioned one with wood backs, and also with ebonite backs can be seen at a glance. Provisional protection for this push has been received, and the design has been duly protected. This company has also brought out a new toy motor, and in connection with it a small model workshop. Similar



electrical toys have been made on the Continent in toy factories, but these makers have given so little attention to the proper construction of the electrical part of the motors, that their introduction into the electrical market has hitherto been a failure. The company has succeeded in making a very nice motor, and as these toys can now be driven by the E.C.C. dry cells, they are a very compact and neat scientific toy, which will find a ready sale on the Christmas market.

The Electric Light in the City.—Although only a fortnight has passed since we published our last report of the progress of electric lighting in the City, we have another long list of installations to present to our readers this week. Since the laying down of the mains, the introduction of electric lighting in the City has been somewhat striking. One point, however, to which we may draw attention is that there is still room for a much larger adoption of electric lighting. So far, its adoption has been principally confined to banking houses, and to the allied business of the stock and share brokers, &c. Electric lighting does not seem to be generally favoured by the "home-trade" warehouses, of which so large a number are to be found both on the north and south sides of Cheapside. As regards the installations at present in progress, we may mention that Messrs. John Pound & Co., Leadenhall Street, are fitting up an installation in the premises of Messrs. Tiffin & Co., 74, Cannon Street.—An installation has just been

completed at the Bank of Africa, Limited, Cannon Street, as also in the premises of the Mortgage Insurance Company, Cannon Street.—Messrs. Laing, Wharton & Down, of New Bond Street, W., are fitting up an installation in the premises of Messrs. J. & J. Colman, the well-known mustard makers, 108, Cannon Street.—In Gracechurch Street, quite a number of installations are in progress.—Messrs. Laing, Wharton & Down are fitting up an installation in the premises of the Royal Bank of Scotland and the National Bank of Australia, and at No. 85, Gracechurch Street.—Installations have just been completed in the premises of Messrs. Wade & Co., tailors, and Messrs. Lynes, tailors.—The premises of Mr. R. Howden, pharmaceutical chemist, are being installed by Messrs. Watson, Geisenheiner & Co., 10, Glasshouse Street, W.; while the City of Melbourne Bank is being installed by the Electrical Supplies and Fittings Company, of Charing Cross Road, W.C.—In the Leadenhall Market, Messrs. Laing, Wharton & Down are fitting up the Grand Avenue Wine Vaults.—In Old Broad Street, the following premises are being installed, or have just been completed:—The Bank of New South Wales, by Messrs. Laing, Wharton & Down. No. 70, by Crompton & Co.—In Queen Victoria Street an installation has been made in the Church of St. Nicholas Cole Abbey, where some artistic fittings may be noticed. The usually gloomy narrow staircase in the tower is now brilliantly lighted.—In Threadneedle Street Messrs. Crompton & Co. have completed an installation at No. 56, while Messrs. Laing Wharton & Down are engaged in installing the premises of the Chartered Bank of India, Australia and China.—In Cheapside, the Atlas Fire Office and the Manchester Fire Office installations have recently been completed, while the Brush Electrical Engineering Company are installing the offices of the Western Union Assurance Company, and Messrs. Barnes & Low, of Exhibition Road, South Kensington, are installing tho new premises of Messrs Harringtons, Limited, confectioners.—Messrs. Moody & Co., of Victoria Street, Westminster, are installing the premises of the Grocers' Company, in Princes Street, and the Royal Bank of South Africa.—Mr. Julius Sax, of Ridgmount Street, W.C., has recently completed an installation at the Bank of China and the Straits, while Messrs. Hayward Tyler & Co., of Whitecross Street, for whom Mr. Killingworth Hedges, of Westminster, is acting as electrical engineer, are engaged on installing the Union Bank of London, Poultry, and the new banking house, now approaching completion, of Messrs. Prescott, Dimsdale, Cave, Tugwell & Company, in Cornhill. Another bank which has recently been installed is the London and General Bank in Budge Row. We will draw our already long list to a close by stating that the Brush Company are installing the new premises of Messrs. R. D. Warburg & Co. in Little Britain, and that Messrs. Siemens & Co., of Westminster, have secured the contract for installing the well known Royal Hotel of Sir Polydore de Keyser, on the Embankment at Blackfriars.

Tenders Wanted.—The committee of the Newcastle Co-operative Wholesale Society, Limited, want tenders for the electric lighting of the whole of their warehouses and offices in Waterloo and Thornton Streets. Full specification and any other information can be obtained from the society's engineer, Mr. John Thompson, C.E., Post Office Chambers, Newcastle-upon-Tyne. Specifications will be supplied on depositing two guineas, and same amount returned on receipt of priced tender. Tenders are to be delivered at the offices of the society on or before July 19th, 1892. The board do not bind themselves to accept the lowest or any tender.

G. North & Co.—Messrs. H. E. Hodgson & Co., of Cleckheaton, makers of engineers' machine tools, have opened an office at 90, Queen Street, E.C., under the management of Messrs. G. North & Co.

Engineering Price Book.—Messrs. E. and F. N. Spon have just issued an engineers' and contractors' illustrated book of prices of machines, tools, ironwork, and general contractors' material. It forms a handsome volume of nearly 600 pages, and contains a large collection of engineering appliances and machinery, displaying the leading manufactures of upwards of one hundred representative firms, offering to the buyer a ready means of selecting the goods best suited to his purpose.

Country House Lighting.—Mr. N. G. Clayton having decided to electric light the new large mansion he is building at Chesters, in Northumberland, the arrangement of the installation, which will comprise some 330 incandescent lights, has been entrusted to Mr. A. A. C. Swinton.

Crystal Palace Electrical Exhibition.—Mr. Tipping says "In the list of awards my name is not quite correctly described—it should be *Henry* Tipping, not H. S.—and the award is for my arc lamp."

Mr. L. A. Groth has been awarded a silver medal for his system of tanning.

New Installations.—Messrs. Evans, Stewart, Palmer & Co., are fitting up electric light at Messrs. Herring and Lake, successors to Chas. S. England & Co., estate agents, auctioneers and valuers, 8, Great Portland Street, S.W.

The General Electric Power and Traction Company, Limited.—This company has received instructions from the War Office to erect a 5-ton electric travelling crane at Woolwich Arsenal. The company has also added another dynamo to the extensive plant at Messrs. Locke & Co.'s, St. John's Colliery, Normanton. The machine was started on Saturday last.

The Electrical Company, Limited.—We are informed that the business heretofore carried on under the name of Keys Electrical Company, Limited, has been reconstructed, and from this date will be known as "The Electrical Company," Limited.

CITY NOTES.

The Edison and Swan United Electric Light Company, Limited.

THE directors in presenting to the shareholders the ninth annual report, and the accounts for the year ending June 30th, 1892, state that the business of the company has resulted in a credit balance of £74,810 16s. 7d. Of this amount £30,271 15s. 11d. has been already distributed as an interim payment on the A shares for the first six months of the year in respect to dividend and arrears. The directors recommend a further distribution of a dividend on the A shares of the company, of 5s. 8¾d. per share on the 89,261 ordinary shares, £3 paid; of 9s. 6½d. per share on the 5,000 £5 fully paid shares allotted to the Edison Electric Light Company, Limited; and of 8s. 10¾d. per share on the 12,139 £5 full paid shares allotted to the Swan United Electric Light Company, Limited, free of income tax, being, with the interim dividend paid on February 22nd, 1892, seven per cent. in respect of the year ending June 30th, 1892; seven per cent. in payment of arrears of cumulative preferential dividend for the year ending June 30th, 1887; and of four per cent. in respect of the year ending June 30th, 1888; all to be distributed in accordance with the provisions of Clause 87 of the Articles of Association, which will absorb £33,354 4s. 9d., leaving £11,184 15s. 11d., which the directors have carried to the reserve fund, in accordance with Clause 89 of the articles of association.

The directors are glad to say that their electrical fittings business is prospering. The amount received as royalty from those who hold licenses for manufacturing holders and sockets for incandescent lamps is satisfactory, and is likely to increase year by year. The directors desire to record their sense of the loss which the company have sustained by the death of Mr. F. R. Leyland. The directors have elected Major Samuel Flood Page, who had been secretary and manager of the company since 1883, to fill the place on the board. The Earl of Lichfield and Mr. Ernest Villiers retire by rotation from the board, and offer themselves for re-election as directors. Messrs. Welton, Jones & Co., auditors, also retire and offer themselves for re-election.

The National Telephone Company, Limited.

THE directors' report for the year ending April 30th, 1892, states that the income accrued in respect of the business of the year amounts to £463,741 5s. 4d., as compared with £431,112 11s. 11d. for the preceding year, being an increase of £32,628 13s. 5d. The working expenses and other charges (excluding debenture and other interest) amount to £236,252 0s. 5d., as compared with £199,483 15s. 8d. for the preceding year, being an increase of £36,768 4s. 9d. The net result for the year, after deducting the Post Office royalties amounting to £40,239 5s. 8d. is a profit balance of £187,249 19s. 3d., as compared with a balance of £195,047 3s. 11d. for the preceding year, being a decrease of £7,797 4s. 8d. It must, however, be remembered that at the end of 1890, in view of the expiration of important patents, a reduction of the tariffs in most of the company's districts was carried into effect. Upon the business of the past year, this reduction has been equivalent to a cession of about £55,000 to the subscribers. Further attention may be called to the fact that the rentals carried forward this year for unexpired terms of running contracts amount to £234,370 11s. 2d. as compared with £204,431 15s. 4d. for the preceding year or an increase of £29,938 15s. 10d. Out of the divisible balance, after providing for interest on debenture stock, an interim dividend for the first half-year has already been paid at the rate of 6 per cent. per annum on the first and second preference shares, and 5 per cent. per annum on the ordinary shares. The board will recommend the payment of a further dividend for the last half-year at the rate of 6 per cent. per annum on the first and second preference shares, and 7 per cent. per annum on the ordinary shares, making with the interim dividend 6 per cent. for the year. The board propose under Article 113 of the Articles of Association to transfer to reserve account £10,000, which with £1,127 3s. 6d. placed to reserve during the year from premium account will bring up the amount of the reserve fund to £104,627 3s. 6d. The directors have acquired on advantageous terms the telephonic business of the Caledonian Telephone Company, Limited, and of the Sheffield Telephone Exchange and Electric Light Company, Limited. A provisional agreement has also been recently entered into for acquiring the undertaking of the Western Counties and South Wales Telephone Company, Limited. The Government have recently determined upon a policy under which it is proposed that all the trunk lines used for inter-town telephonic communication shall become the property of and be worked by the State, the exchanges and local service remaining in the hands of the companies for the term of their present licenses. An Act confirming this policy and granting the necessary powers has just been passed by Parliament. Under its provisions the trunk lines of this company can be acquired by agreement for money payment and other adequate compensation. The board, after much anxious consideration, have decided that as licensees of the Postmaster-General it will be their duty, on fair terms, to co-operate loyally with him in giving effect to a policy having for its expressed object the expansion and improvement of the telephone service of the kingdom, hitherto so seriously hampered and retarded for want of sufficient legal powers for carrying out such works as are absolutely essential if efficiency is to be attained. With this object in view negotiations with the Government are now pending. Since the last annual meeting the company has suffered a severe blow in the death of its late president, Mr. F. R. Leyland. His colleagues on the board desire to express their sense of the great loss which they have sustained by his death in being deprived of a valued coadjutor and friend. To fill the vacancy thus caused, the board have appointed Mr. George Franklin, of Sheffield, as a director, with a view of securing representation on the board of one of the most important commercial centres of the undertaking. The magnitude of the company's business has rendered necessary

the appointment of a general manager, and the board have secured the services in that capacity of Mr. Wm. E. L. Gaine, who resigned the office of town clerk of Blackburn to take the position. The following directors retire at this meeting, and being eligible offer themselves for re-election, viz., Mr. James Staats Forbes, Colonel Robert Raynsford Jackson, Mr. Eli Heyworth, and Mr. Samuel Herrick Sands. The auditors, Messrs. Welton, Jones & Co., also retire, and are eligible for re-election.

The twelfth annual meeting of the shareholders of the National Telephone Company, Limited, was held at the Cannon Street Hotel on Thursday, July 14th, when there was a good attendance.

Mr. JAMES STAATS FORBES presided, and after it had been decided to take the report as read, remarked that since they last met they had sustained a grievous loss in the awfully sudden and almost tragic death of their late president. Literally, he died in harness, and his very last thoughts and his very last words were of this company, of its affairs, and of its interests. He went straight from the office where he had laboured ungrudgingly for the company, and in ten minutes he was gone. These things had to be met, and of the deceased they could certainly say *nil nisi bonum*. At the request of the directors he (Mr. Forbes) consented for the time to fill the void. Now they came to the report. The income had been £463,741 5s. 4d., as compared with £431,112 11s. 11d. for the preceding year—an increase of £32,628 13s. 5d. The working expenses and other charges (including debenture and other interest) came to £236,252 0s. 5d., as compared with £199,483 15s. 8d. for the preceding year—an increase of £36,768 4s. 9d. After deducting the Post Office royalties (£40,239 5s. 8d.) the net result for the year was a profit balance of £187,249 19s. 3d., compared with £195,047 3s. 11d. in the year before—a decrease, he regretted to say, of £7,797 4s. 8d. It should be pointed out, however, that at the end of 1890, in view of the expiration of important patents, the company carried into effect a reduction of the tariffs in most of its districts. This reduction had been equivalent, upon the business of the past year, to a cession of about £55,000 to the subscribers. He called attention to the fact that the rentals carried forward this year for unexpired terms of contracts came to £234,370 11s. 2d., as compared with £204,431 15s. 4d. in the preceding year, equal to an increase of £29,938 15s. 10d. Out of the balance an interim dividend had already been paid at the rate of 6 per cent. per annum on the first and second preference shares, and 5 per cent. on the ordinaries, and the board recommended the payment of a dividend for the latter half of the year at the rate of 6 per cent. per annum on the first and second preference shares, and 7 per cent. on the ordinaries, which, with the interim dividend, made 6 per cent. for the year. The Chairman next called attention to the fact that the company had acquired, on distinctly advantageous terms, the telephonic business of the Caledonian Telephone Company, besides that of the Sheffield Telephone Exchange and Electric Lighting Company. The latter, however, would continue to carry on its electric lighting business. There had been an increase of 20 per cent. in the number of subscribers or wires. That was not a bad record, especially as they had reason to believe that the march of progress in that direction would not diminish but increase. At the same time there was an increase in the cost of conducting the business of 18 per cent., which had not quite kept pace with the increase of business done. The company had emerged from Protection, and were now in the more healthy atmosphere of Free Trade, and they were glad to be able to report that not only was business good and subscribers increasing, but the outlook for the future was pleasant and satisfactory. Naturally, there was the promise of competition—there were always people ready to bid for a ready-made business; but they had anticipated all that. In railway matters, they were accustomed to speak of "train miles," and they had had to find a similar factor in telephony. It was ascertained that the number of "subscribers" would not do; the nearest thing was "lines," in which, as he had said, there was a 20 per cent. increase. He complained that they were not given by Government a fair chance to expand. The Post Office had acquired a monopoly of the telegraphs at a high figure, and they were naturally careful not to allow their business to be injured if they could help it, but he thought the Government ought to buy up and secure a monopoly of the telephone system if they were not prepared to give fair terms to the companies. As sure as the morning followed midnight, the telephone was going to supersede the telegraph. The Post Office, as a Government Department, had the prestige of the State at its back, and they could do things which a private company could not do. They had popularised the telegraph service by giving sixpenny messages, and what was the result? Their messages, of which they last year sent about sixty millions, cost very nearly 9d. each, on the average, though the bulk were sixpennys, while that telephone company carried some 160 million oral messages at an average cost of three half-pence each). He thought the telephone system to succeed and develop fully must be in one hand or the other—if the Government did not take it over and work it as a monopoly it ought to allow a company to do so on fair terms. It was in its nature as much of a monopoly as the carrying of letters or the sending of telegrams, and as a monopoly it must be either in the hands of the Government or in those of a company—that was the only way in which to secure efficiency and economy. He moved the adoption of the report.

Col. JACKSON seconded.

The CHAIRMAN, in answer to Mr. Biden, said he had heard of the New Telephone Company, which, however, was a good deal in the air, and dependent on promises. He hoped the New Telephone Company would be wise in time and not be so foolish as to enter into competition with a larger and well established company. If they did enter on that competition, it must lead to the New Telephone Company's ruin.—The report was adopted unanimously.

Chili Telephone Company.

THE annual general meeting of the shareholders of the Chili Telephone Company, Limited, was held on Friday last at Winchester House, Old Broad Street, Col. R. Raynsford Jackson in the chair.

The SECRETARY (Mr. Edmund Petley) read the notice convening the meeting.

The CHAIRMAN, in moving the adoption of the report, said it was conspicuous for two leading features, one which they might consider an adverse one, and one which was beneficial, and which led them to hope for better things in the future. The adverse feature in the report was that the profits were less than in the previous year. The net profit in sterling paid the last year was £6,067, which was £7,622 less than the profit in the previous year. The shareholders all knew why the profits were less. A fierce revolutionary war had disorganised every interest in Chili, and theirs among the rest. One of the consequences of this had been a wholesale destruction of lines, poles, and works, necessitating a large increase in the expenses for repairs. At the same time, however, their receipts in Chili were but very little less, and that led them to hope for a rapid increase of business there. In 1890-1 the receipts were $387,110, while in the year before they were $378,830, showing a difference of $8,280. The effect of the war having been to rednce the receipts by 2⅛th per cent. only. That was a change from the previous year, when the increase was 47 per cent.; but there were indications that for the remaining portion of the current year their revenue would progress at the old rate. The new revenue secured in April was £7,960 and in May £7,690, and that led them to hope that the disorganisation was past and that they might expect to increase their revenue and make their position secure. Although the diminution in the receipts in Chili was only $8,280, the expenses were $76,120 more, and the dollar was worth only 19½d. as against 24d. in the previous year, which militated against the profits as reckoned in sterling. The shareholders were aware from last year's report that they had to manage their business through the instrumentality of a general manager appointed by the West Coast Telephone Company, or rather, their manager received also the appointment to the West Coast Telephone Company. It was further stated in that report that a minority of the shareholders of the vending company opposed the sanction by the Courts of the transfer of the West Coast Telephone Company to this company. That opposition had since been withdrawn, and the title of the Chili Telephone Company to their property had been duly and legally registered. On the favourable side was the important fact that an arrangement had been entered into with the Government of Chili, and the authorities of Santiago and Valparaiso, for a telephonic service for 10 years. This would strengthen their position and assist in the development of the company, and the directors were led to think that the time had come when they might safely regard the earnings of the company as legitimately the property of the shareholders in the form of dividend. All their earnings had, however, been spent in Chili, and treated as capital. That had been done because if they were to attempt to raise capital at the present time, they would have to do so on very unfavourable terms. Under these circumstances, they thought it expedient to issue deferred warrants, payable when capital was in hand from the earnings of the past two years, giving an option to the shareholders to convert these warrants into shares before March 31st, 1893. The directors hoped the shareholders would convert these warrants, because the effect would be to increase the capital of the company in an easy manner by £20,000.

Mr. THOMAS GREENWOOD seconded the motion for the adoption of the report.

In reply to some remarks from Dr. LEESON and other shareholders,

The CHAIRMAN said they had put in a claim on the Government of Chili for $115,000, but how far that claim would be recognised he could not say. Such of the warrants as were not converted would be paid off when the directors thought the state of the funds allowed of it being done.

The motion for the adoption of the report was then put and carried.

On the motion of the CHAIRMAN, seconded by Mr. GREENWOOD, a resolution authorising the issue of deferred warrants was carried unanimously.

The retiring director and auditor were re-elected, and a vote of thanks to the chairman closed the proceedings.

Western Counties and South Wales Telephone Company, Limited.

AN extraordinary general meeting of the above company was held at the Grand Hotel, Bristol, on Friday, when resolutions, which were passed on the 21st ult., were submitted for confirmation. Mr. C. Nash presided.

Mr. HENRY F. LEWIS (general manager and secretary), having read the convening notice,

The CHAIRMAN moved the adoption of the resolutions as follows:—(1) That the agreement submitted to this meeting, and expressed to be made between this company and the National Telephone Company, Limited, for the amalgamation of the two companies, by a transfer of the business and property of this company (with certain exceptions) to the National Telephone Company, Limited, be, and the same is hereby, approved. (2) That with the view of giving effect to the agreement, and in order to enable the shares to be allotted thereunder as part of the purchase consideration, to be distributed among the members of this company, this company be wound up voluntarily under the Companies Acts, and that Mr. Thomas Abercrombie

Welton, of Moorgate Street, London, chartered accountant, be, and he is hereby, appointed liquidator for the purpose of winding up its affairs and distributing its property. (3) That pursuant to the 161st section of the Companies Act, 1862, the liquidator be, and he is hereby, authorised to carry the said agreement into effect, and to receive the shares agreed to be allotted, and the cash payable thereunder, and to distribute the same among the members of this company.

Mr. MARK WHITWILL seconded the resolutions.

Mr. GEORGE WHITE, who opposed the scheme at the last meeting, asked whether any director had made an arrangement with regard to his own shares, or any over which he had control, with the National Company of dealing with them on a different basis to that upon which ordinary shareholders were to be dealt with.

The CHAIRMAN, Mr. Robertson (representing the National Company), and several directors replied that nothing of the kind had occurred.

Mr. WHITE, proceeding, said that since the last meeting he had taken counsel's opinion with reference to the probability of dissentient shareholders upsetting the agreement. Counsel advised most strongly and clearly on the point, but even if they succeeded in upsetting the agreement there would be still the question whether or not they could dissolve the liquidation. For his own part he did not think it wise to take those proceedings, even if he were to be successful in upsetting the sale to the National Company, because he should find himself thrown back in the hands of the liquidator, who would be allowed to deal with the property as he chose. That was the difficulty, and although he should have been prepared to test the question at his own expense, he felt that if he upset the sale he would be landing the shareholders in a difficulty. Accordingly he did not intend taking further proceedings.

The resolutions were confirmed by 10 to 6.

Mr. JAMES INSKIP, the company's solicitor, explained that the Postmaster-General had granted a licence to that company and the National, but if that company or their liquidator attempted to transfer the licence, there was no reason to anticipate that the Postmaster-General would sanction the transfer. The consequence was that a company wishing to sell its business was limited in its negotiations to dealing with those companies which already held the licence of the Postmaster-General.

Mr. ROBINSON moved a vote of thanks to the chairman and directors for their past services.

Mr. WHITE objected, saying that the tenour of the previous meeting was distinctly against the directors.

The CHAIRMAN said he would not trouble them, but would simply thank Mr. Robinson on behalf of himself and his co-directors.

Electrical Power Storage Company, Limited.

THE report of the directors, to be presented to the shareholders at the third ordinary general meeting, to be held on Wednesday, July 20th, 1892, at the offices of the company, 4, Great Winchester Street, London, E.C., at 12.30 p.m., states that the gross profits and other sums receivable amount to £37,045 12s. 2d. The directors have made provision for maintenance of buildings, plant and tools, and depreciation, by writing off the sum of £1,401 6s. 1d. The net profit, after payment of general expenses, management, &c., is £5,763 11s. 9d., out of which the directors propose to pay a dividend of 6 per cent. on the paid-up capital of the company.

This will absorb £5,017 4s. 2d., and the remainder, viz., £746 7s. 7d., the directors propose to carry forward to next account.

The directors have during the past year completed the necessary arrangements for changing the name of the company from the Foreign and Colonial Electrical Power Storage Company, Limited, to "Electrical Power Storage Company, Limited," thus restoring to the company the prestige of the old E. P. S. name.

During the past twelve months the company had acquired a lease of the Storage Battery Manufacturing business previously carried on by the Electric Construction Corporation at Millwall and Wolverhampton, and included in this lease is the use of the plant, machinery, and, for a period of three years, of the stock existing at Millwall, where the business is now carried on.

The accounts have been made up to May 31st, 1892, as at that date the lease of the manufacturing business from the Electrical Construction Corporation, Limited, had been in existence twelve months. The shareholders will note with satisfaction from the profit above mentioned that the business of the company exhibits marked vitality.

The patents of the company have been upheld abroad by legal decisions, which should have a beneficial effect upon the general business of the company.

The utility of secondary batteries for the work of central electric lighting stations, and the absolute necessity of such apparatus in private lighting installations being now generally admitted, the directors are devoting attention to the commercial application of the secondary battery to electric traction. Very considerable success has attended the use of the company's batteries for electric launch work. Some thousands of cells are, and have been, in use for this purpose during the past five years.

Much activity exists among the various engineers, who are endeavouring to develop commercial methods of electrically propelling tramcars, omnibuses, and other vehicles, and the company is in a position to profit by the successful result of their labours.

The directors are pleased to report that at the Crystal Palace Electrical Exhibition, 1892, the company received the only gold medal for storage batteries.

The retiring directors are Mr. Frederick Green and Mr. James Pender, who, being eligible, offer themselves for re-election. The auditors, Messrs. Broads, Paterson & Co., also offer themselves for re-election.

PROFIT AND LOSS ACCOUNT from January 1st, 1891, to May 31st, 1892.

DR.	£	s.	d.
Rent, licenses, taxes, &c....	6,016	8	2
General expenses, management, directors' fees, &c. ...	11,231	11	3
Advertising, insurances, and travelling expenses ...	2,141	0	1
Discount, interest, commission, &c.	5,296	4	11
Patent Fees and charges, and law expenses	2,579	19	8
Maintenance of buildings, plant, and tools, and depreciation written off	1,401	6	1
Balance of profit and loss account at December 31st, 1890	2,615	10	3
Balance of net profit carried to balance-sheet ...	5,763	11	9
	£37,045	12	2

CR.	£	s.	d.
Balance from trading account	36,551	14	0
Rents receivable, &c.	493	18	2
	£37,045	12	2

BALANCE SHEET, May 31st, 1892.

LIABILITIES.

	£	s.	d.	£	s.	d.
Capital authorised— 20,000 ordinary shares of £5 each, 100 founders' shares of £5 each	100,500	0	0			
Shares issued— 15,070 shares fully paid, of which 70 are founders	75,350	0	0			
3,537 shares, on which £3 per share has been called up	10,611	0	0			
	85,961	0	0			
Less calls in arrear	1,475	0	0			
				84,486	0	0
Current accounts owing by the company				5,195	8	11
The Electric Construction Corporation, Limited, on account of stock				13,046	17	7
Profit and loss account—Balance				5,763	11	9
				£108,491	18	3

ASSETS.

	£	s.	d.	£	s.	d.
Patents, &c., at cost				75,160	0	0
New plant, tools, furniture, fixtures and fittings	903	11	9			
Less 5 per cent. depreciation	45	0	0			
				858	11	9
Stock on hand				11,473	9	7
Current accounts due to the company ...				11,116	3	7
Cash—						
At bankers	9,786	19	3			
In hand	96	14	1			
				9,883	13	4
				£108,491	18	3

We have examined the above accounts with the books and vouchers of the company, and find the same to be correctly stated in accordance therewith.

BROADS, PATERSON & CO., *Auditors*,
1, Walbrook, E.C.

July 6th, 1892.

Telegraph Construction and Maintenance Company.

A half-yearly general meeting of this company was held on Tuesday, at 38, Old Broad Street. Sir George Elliot, who presided, stated that during the past half-year they had carried out a contract with the Western and Brazilian Company by laying about 770 miles of cable along the coast of Brazil between Santos and Chuy, and had made various repairs in that company's cables on the same coast. They had laid a cable nearly 300 miles in length along the eastern coast of Sumatra for the Dutch Government (through the Eastern Extension Company); they had made several repairs in the German Government cable between Emden, on the river Emms, and Valentia, in Ireland; they had likewise made repairs in the Direct United States Company's cable on the banks of Novia Scotia. Their general business had been fairly good compared with a similar period of last year. On the motion of Mr. Hewat, a vote of thanks to the chairman and directors closed the meeting.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending July 10th, 1892, were £733; corresponding month, 1891, £692; showing an increase of £41.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending July 8th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited, amounted to £2,790.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.	Closing Quotation, July 7th.	Closing Quotation, July 14th.	Business done during week ending July 14th, 1892. Highest.	Lowest.
250,000£	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	99 —103xd	99 —103	102	...
1,300,980£	Anglo-American Telegraph, Limited	Stock	48 — 49	48 — 49	...	...
2,849,510£	Do. do. 6 p. c. Preferred	Stock	88 — 89	88 — 89	88½	87⅞
2,849,510£	Do. do. Deferred	Stock	10⅜ — 11¼	10½ — 11	10⅜	...
130,000	Brazilian Submarine Telegraph, Limited	10	10¼ — 10⅜xd	10¼ — 10⅜	10 1/16	10¼
53,200£	Do. do. 5 p. c. Bonds	100	101 —104	101 —104	...	...
75,000£	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	103 —107xd	103 —107	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	2⅞ — 3⅛	2⅞ — 3⅛	3 5/16	2 15/16
69,996	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅛ — 2⅜	2⅛ — 2⅜	2 5/16	...
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3½ — 4½	3 — 4	...	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	2½ — 3½	2½ — 3½	...	...
30,152	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152 ...	10	10 — 10½	9¾ — 10¼	10⅛	10
$7,716,000	Commercial Cable, Capital Stock	$100	155 —160	155 —160	157	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	⅛ — ⅜	⅛ — ⅜	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5½ — 6	5½ — 6	...	...
16,000	Cuba Telegraph, Limited	10	11 — 12	11 — 12	11⅜	11¼
6,000	Do. do. 10 p. c. Preference	10	16½ — 17½	16½ — 17½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3¼ — 3⅜	3¼ — 3⅜	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	11⅜ — 11⅝	11⅜ — 11⅝	11 9/16	11 9/16
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅜ — 15	14⅞ — 15⅛	15⅛	14⅞
70,000	Do. 6 p. c. Preference	10	15¼ — 15⅜	15½ — 16	15⅜	15¼
200,000£	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	108 —111	108 —111	110	...
1,200,000£	Do. 4 p. c. Mortgage Debenture Stock	Stock	108 —111	108 —111	111	109½
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15 — 15¼	14⅞ — 15⅛	15¼	15 1/16
78,300£	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	101 —104xd	102 —105	103⅜	...
276,200£	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	101 —104xd	102 —105	...	...
320,000£	Do. 4 p. c. Debenture Stock	Stock	108 —111	108 —111	...	...
135,000£	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	103 —103xd	101 —104	101⅝	...
180,400£	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	100 —103xd	101 —104	102½	...
201,600£	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	102 —105	102 —105	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	4⅜ — 5¼	5¼ — 5⅜	4⅝	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1⅜ — 1⅝	1⅜ — 1⅝	...	...
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	2⅜ — 2⅝	2⅜ — 2⅞	2⅝	2 1/16
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd,	2	1⅛ — 1⅜	1⅛ — 1⅜	1 3/16	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	10⅛ — 10⅜	10⅛ — 10⅜	10⅜	10⅛
180,042	Do. do. 6 p. c. Preference	10	15⅛ — 15⅜	15⅛ — 15⅜	15⅜	15⅛
150,000	Great Northern Tel. Company of Copenhagen	10	18½ — 19xd	18⅝ — 19	18 9/16	18½
220,000£	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	106 —109	106 —109	...	...
12,134£	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	7⅜ — 8¼	7⅜ — 8¼	...	...
9,600£	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9½ — 10¼xd	9½ — 10½	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	20½ — 21½	20 — 21	21⅛	21¼
200,000£	Do. do. 4½ p. c., Deb., 1896	100	104 —106	104 —106	...	...
17,000	Indo-European Telegraph, Limited	25	40 — 42	40 — 42	...	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	3½ — 4½	3½ — 4½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	6½ — 7½	8 — 9	...	...
30,000	†Liverpool Electric Supply, £3 paid	5	3 7/16 — 3 9/16	3 7/16 — 3 9/16	3½	3¼
10,000	Do. do. fully paid	5	5 1/16 — 5 3/16	5 1/16 — 5 1/16	5⅛	4⅞
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000£	Do. do. do. 6 p. c. Debentures	100	107 —110	107 —110	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	6½ — 7	6½ — 7	6¾	...
447,234	National Telephone, Limited, Nos. 1. to 438,984	5	4½ — 5⅛	4½ — 5⅛	5⅛	4 13/16
15,000	Do. 6 p. c. Cum., 1st Preference	10	13¾ — 14¼	13¾ — 14¼	...	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	12¾ — 13¼	12¾ — 13¼	13¼	13⅛
420,000£	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	108 —110xd	108 —110	109¾	108¾
250,000£	Do. (issued at 5 p.m., all paid)	...	108 —110xd	108 —110	...	...
6,318	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	4 — 5	4 — 5	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16 — 5/16	3/16 — 5/16	...	...
9,000	Reuter's Limited	8	7 — 8	7 — 8	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	8 — 8¼	7¾ — 8¼	8 3/16	8⅛
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	8 — 8¼	8 — 8¼	8⅛	...
3,381	Submarine Cables Trust	Cert.	115 —120	115 —120	...	...
78,949	Swan United Electric Light, Limited ... ... (£3¼ only paid)	5	3¼ — 3⅜	3¼ — 3⅜	3⅜	...
37,350	Telegraph Construction and Maintenance, Limited	12	45 — 47	45 — 47	45¼	...
150,000£	Do do. do. 5 p. c. Bonds, red. 1894	100	103 —106xd	103 —106	...	...
58,000	United River Plate Telephone, Limited	5	1½ — 2½	1½ — 2½	...	...
146,370£	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95xd	85 — 95	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	6 — 8	6 — 8	...	...
271,400£	Do. do. 5 p. c. Debentures	100	100 —103	101 —105	102⅜	102¼
30,000	West Coast of America Telegraph, Limited	10	3½ — 4½	3½ — 4½	3⅞	3¾
150,000£	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	101 —105xd	101 —105	...	...
67,007	Western and Brazilian Telegraph, Limited	15	8⅜ — 9¼	8⅜ — 9¼	...	...
30,364	Do. do. do. 5 p. c. Cum. Preferred	7½	6 — 6½	6 — 6½	...	...
30,364	Do. do. do. 5 p. c. Deferred	7½	2⅜ — 3¼	2¼ — 3¼	...	...
189,700£	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	105 —108	105 —108	...	...
237,200£	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	105 —108	105 —108	...	...
88,321	West India and Panama Telegraph, Limited	10	1¼ — 1½	1¼ — 1½	...	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	9½ — 10	9½ — 10	...	...
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8 — 9	8 — 9	...	...
60,000£	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	102 —106xd	102 —105	...	...
$1,536,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	118 —122	118 —122	...	...
173,100£	Do. do. 6 p. c. Sterling Bonds	10J	100 —103	100 —103	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	6¼ — 6⅜	6¼ — 6⅜	6⅜	6 1/16

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid 7½—7⅝.—Electric and General Investment, shares of £5 (£1 paid), 2⅜—3⅛.—Founders' shares, 200—225.—Elmore Foreign and Colonial Copper, Founders shares, 6⅜—7⅛.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20⅛.—Founders' shares, 10—20.—Halifax and Bermuda Cable 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 2⅛—3⅛.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅜—6, 1st Preference Cumulative 6 per cent., £5 (fully paid), 5⅛—6.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—⅜.—Metropolitan Electric Supply Company, Founders' Shares, 50—150.—Queen Anne's Mansions Lighting and Heating, Deferred shares of £10 (fully paid), 10—⅛.—Do. 4½ per cent. preference shares of £10 (fully paid), 10—⅛.—Do. Debentures, 103—⅛.—Woodhouse & Rawson Ordinary of £5 (£3 10s. paid), ⅛—¼.—£5 Preference (fully paid), 2⅛—3.—Ward's Electric Car (£10 paid), 1⅛—1⅜.

BANK RATE OF DISCO .—2 per cent. (April 28th, 1892).

ELECTRIC TRACTION FOR TRAMCARS.*

BY L. EPSTEIN.

[COMMUNICATED.]

IF possessed of no other merit, I hope I shall be able to claim for my paper the merit of brevity, and I will endeavour to cover, within the short space of time allotted to me, viz., 20 minutes, as long a line of track as the system of accumulators which, with your permission, I am going to bring under your notice, will permit me. I will, to use an electrical expression, discharge my paper at a very high rate.

Having occupied myself for the last 12 years almost exclusively with the study and manufacture of secondary batteries, I had arrived, about two years ago, at a point which not only by myself (who might be accused of the sanguine feeling inherent in inventors) but also by others upon whose common sense and clear judgment reliance may be placed, is considered to be as near perfection as any contrivance may be said to be, I have the pleasure of showing you here one of the accumulators, which are specially adapted for propelling tramcars or other vehicles. You will see that this accumulator, unlike other cells, is composed of only three electrodes, which are contained in an ebonite box. There is no paste used in the manufactnre of these cells, but the parts which are active, that is to say, which take up and give out again the electrical energy put into them, are produced out of the original substance of the lead itself.

To those gentlemen who take an interest in this matter, I can show some plates here in the different stages of manufacture. The great point is that the so-called active material cannot, by any possible means, become detached, and that therefore there is no risk of material dropping off and damaging the accumulators when in use. There is also no danger from warping of the plates, which, as you will see, are very thick and robust, and therefore well adapted for the work for which they are intended. One of these cells, complete with acid, weighs about 45 lbs., and as generally 96 cells are used on a tramcar, the weight of the battery complete is a little under two tons, or about one-fifth of the total weight of the car, which, with its full complement of passengers, is a little over 10 tons.

This battery of accumulators will allow the car to run at an average speed of 7½ miles for about 4 hours, leaving a sufficient reserve in the accumulator to provide for any unforeseen emergencies. This running for 4 hours is under the assumption that the average expenditure of the battery is about 6 H.P., and the weight of the battery corresponding to 1 H.P. is therefore about 750 lbs. But if it should be desired, this battery can be discharged at twice the above rate, in two hours; that is, if provisions are made to exchange the batteries every two hours, the battery can be made to give out 12 H.P., therefore the weight of the battery corresponding to 1 H.P. is in this case only about 370 lbs.

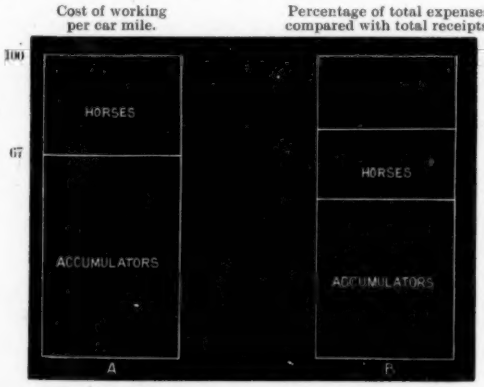
These acumulators have the further advantage that if not required they may be left idle for any length of time without incurring expense. They are in this respect more economical than horses, which, as you are only too well aware, require fodder and attendance whether doing work or standing idle.

Or, again, compared with horses, accumulators may claim to a much more certain and satisfactory state of health—glanders, skin diseases, pink eye and other contagious diseases being unknown among them.

The further advantages are, the roadways are kept clean; there is no dirt or smell, and the cars are lighted at the same time from the accumulator in a much more efficient manner than is the case now.

I am afraid I have already taken up too much of your time in matters relating solely to accumulators and I will, therefore, pass to another point, which may prove of more general interest. I am alluding to the question of £ s. d., and I will, with your permission, briefly glance at the cost of tramway traction by means of horses and the same by means of the accumulators which you see represented here by this cell.

The experience gained in the United States, and also some towns in England, has shown that an electrically-propelled car can complete



several more runs per day than a horse car, as not only can they run faster, but the rest required by horses is, of course, absent in the case of electricity, and it has been found that electrically-propelled cars have a proportionately higher earning capacity.

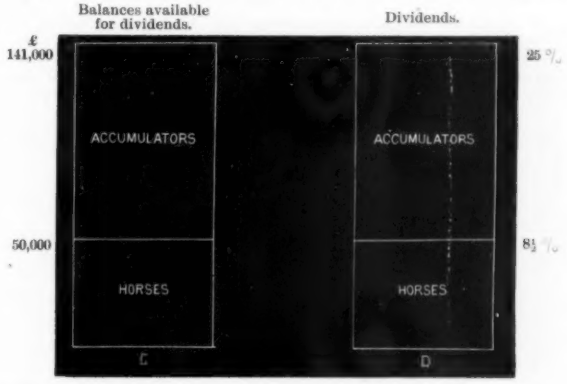
* Read before the meeting of the Tramway Institute, June 28th, 1892.

I have prepared some tables which will enable you to compare at a glance the relative merits of the two systems. In this table (Table A) the costs of working a car mile find expression. You will see that if we call the cost per car mile worked by horses 100, the cost per car mile of the same line, if worked by means of our accumulators, is expressed by the figure 67, or, in other words, that a saving of about one-third is effected in the latter case.

The next table (Table B) shows graphically the percentage of total working and general expenses as compared with total receipts. If we express the total receipts by the figure 100, the total expenses in the case of horses amount to a little over 76 per cent., while the total expenses with accumulators only amount to about 54 per cent. While, therefore, horses appropriate more than three-quarters of the total receipts, the equivalent figure with accumulators is only a little over half.

In Table C, the balances available for dividends are shown, and, as will be seen, the £50,000 available with horses are increased to £141,000 in the case of accumulators. The last table (Table D) shows a comparison of the dividends: 8½ per cent. in the case of horses and 25 per cent. in the case of accumulators.

I am aware, gentlemen, that these figures will, perhaps, meet with some doubt, and that the remark will be made that, however well they may look upon paper, very different results may accrue when put to actual test; but there is really no reason to doubt that these figures—at least, very nearly—express the truth. The cost of not only the accumulators, but the whole of the electrical installation, has



been carefully worked out, and will stand the test of rigid examination. If the estimate errs at all, it will, I think, be found to err on the safe side.

Now, with regard to the expenditure. The cost of working is based on figures derived from actual running. The cost of fuel is well known. The depreciation of the boilers, engines, dynamos and motors is liberal; therefore the only item that might be open to doubts is the cost of renewal of the accumulators; but also on this point I think proof can be adduced that the estimate is a safe one. Our accumulators have been tested under conditions which are much more severe than those which they will encounter when in use on a tramway. They have been discharged at much higher rates; they have been left idle, both after a charge and after a discharge, for periods up to three months; all this without being damaged, so that there is really no reason to anticipate that the cost of maintenance will be more than, at the outside, 1d. per car mile.

Looking at it from the point of view of the manufacturer, this can be further explained by the fact that where accumulators of this type are being used they only require the renewal of one plate, which plate is produced by casting, and as the lead of the old plate is recoverable, only a very little additional expenses for loss and wages is incurred.

Before concluding, I will just glance at the relative merits and demerits of the accumulator system and the overhead or trolley system, and the system of underground conductors. These systems can claim a less weight of car, but this is its only advantage, as far as the trolley system is concerned; while, on the other hand, it possesses many—and some very great—disadvantages. Among them may be mentioned unsightliness of the overhead structure, the danger consequent upon the snapping of a wire, the impediment in case of frost when the wires are frequently covered with a thick crust of ice, and the trolleys, therefore, make very imperfect contact; and the flooding of the rails conveying the return current, after heavy rains, when special cars have to be sent out to sweep the roadway.

The first cost of the two systems is about the same, but the efficiency of a good accumulator system is far higher than the efficiency of a trolley system. A calculation based on the working of the different lines on the trolley system in the United States have elicited the remarkable fact that the efficiency, viz., the proportion of the brake H.P. on the car motor, as compared with the indicated H.P. at the generating station amounts, in some cases, to only 25 per cent., and exceeds, in no case, 40 per cent. in everyday practice, or an average of 32 per cent.

The correctness of these figures will be easily recognised when we bear in mind that the generating station must be capable of furnishing the maximum current at any given moment, while the average current falls far short of the maximum, and, as it is well known, an engine works most economically near its maximum load, and less and less economically with a decreased load, the correctness of the figures, which at first sight may appear rather startling, will soon become apparent.

Although I have not so many figures at my disposal regarding the efficiency of an underground system, yet, as the conditions of work-

ing are almost identical with those on the trolley system, there is no reason to assume that the efficiency of such a system is any higher. A further great disadvantage of the underground conductors is that the construction of the line is very expensive. Both systems, the trolley as well as the underground, have the great disadvantage that where existing lines are to be converted into electrical lines, the conversion interferes with the existing traffic; in the case of underground conductors much more so than in the case of the trolley system; while, on the other hand, provided only that the rails are in good condition, a horse line may be almost instantly be converted into a line driven by means of accumulators.

With an accumulator system the efficiency is much higher than with either the trolley or underground system, and it will, I presume, interest you to learn the results of some experiments which were carried out at our works, under rather severe conditions. The batteries were discharged in three hours, and were charged again in three hours, without the use of any intermediate resistance, thus utilising the whole of the current for the battery. We found that it was only necessary to charge the battery with a current that exceeded the previous discharge by 5 per cent., and the efficiency, that is, the total energy given out, as compared with the total energy put into the cells under these very trying conditions, was still as high as 78 per cent. Allowing for loss in dynamos, gearing and motors, we arrive at the efficiency of 63 per cent. between the H.P. generated by the engines, and the brake H.P. on the car motors; and allowing 25 per cent. for the increased weight of the accumulator car, we arrive at a total efficiency of 47 per cent., as against 32 per cent. of the trolley system. The explanation may be found in the fact that in the case of accumulators, the central stations, which need not be so large as in the case of direct current, can always be used at their full capacity, no fluctuations of the output taking place, and the engines working much more economically.

Another great advantage is that each accumulator car is self-containing, and independent of the central station, so that any breakdown at the central station does not interfere with the working of the line, while with direct current, whether it be conducted to the cars by means of overhead wires or underground conductors, an accident at the central station may interrupt the traffic on the whole of the line, and bring all the cars on the road to a standstill.

I hope to be able, at no very distant date, to supply you with figures derived from the actual working of our accumulators on different tramways.

LEGAL.

Lane-Fox v. The Kensington and Knightsbridge Electric Lighting Company, Limited.

(*Continued from page* 55.)

IN accordance with the understanding arrived at before Lord Justices Lindley, Lopes and Kay, in the hearing of the appeal in this case, as reported in the last two numbers of the ELECTRICAL REVIEW, we understand that Mr. Lane-Fox has filed the following answer to the summary of counsel's arguments for the defendants.

Dealing, first, with the appeal against the decision of Mr. Justice Smith in the Court below, it is submitted:—

1. It is not disputed that full battery has higher voltage than empty, whatever be the surface; neither is it disputed that if large currents are forced into and drawn out of a small battery there may be considerable difference in the voltage of the charging and discharging curves. Such difference in voltage, however, means waste of energy. With charging and discharging currents of any amounts from large enough batteries there are only small differences in voltage between charge and discharge even for considerable periods. Ayrton states that his curves are for the largest currents which the manufacturer thought it safe to use. Even Crompton (see question 7,407) published a statement long before this trial of very much smaller percentage differences of potential from complete charge to complete discharge than are shown on Ayrton's curves. Even in the most extreme case Ayrton's curves, in discharge, only show a total change from 110 to 98, or less than 6 per cent. up and 6 per cent. down, taking the normal voltage of the mains and lamps at 104. Mr. Justice Smith admits that this range of 6 per cent. above and below normal may be used in practice. His Lordship (Mr. Justice Smith) seems to have thought that the lamp must be a 100-volt lamp, whereas lamps of various voltages are used, and obviously a 104-volt lamp would not be injured at 110, according to Mr. Justice Smith's judgment.

2. If it is necessary to charge 50 cells above 110 volts, let normal pressure of mains and lamps be 110, or thereabouts. Or use fewer cells if normal pressure of mains 100 volts. (*a*) Sufficient storage depends on size of batteries, but even taking Ayrton's curves about ¾, full storage capacity of cell is obtained without passing 110 volts, and within 6 per cent. up and down range. (*b*) Flicker is regulated at all points of charge and discharge of cells. (*c*) Planté's batteries did not deteriorate, and he expressly states that bubbling, *i.e.*, high voltage, is undesirable (Bramwell, 4,373), (Forbes, 3,927 to 3,931) (Barrett 3,316 and 3,265) Lane-Fox system can be worked without switches also switches were obvious additions (Barrett's evidence and Lane-Fox 1,985).

Lane-Fox Case is supported by evidence. (*a*) Chemical action is cause of static voltage (*i.e.* voltage on "open circuit," when battery is neither charging nor discharging) whether full or empty. Why do defendants refer to this as applying only to 100 volts? This is most misleading, as chemical action applies to all static voltages of a cell, whether full or empty. Moreover, point B on Ayrton's curve (110 volts) is considerably above the static voltage at that moment (Crompton 7,531 to 7,532). The second part of (*a*) is in plaintiff's favour, for it also means that the *same* current at *less* pressure is required, as battery has larger surface, which is his contention. He was thinking of both. The defendant's batteries cost only a very small percentage of whole capital. *Re* Crompton's cell, see remarks, page 674, lines 35 to 45, Crompton's results untrustworthy, contradicted by King's and Drake's curves. See also Crompton, question 7,407.

3. There is no disconformity. (*a*) Use of word "reservoir" implies *regulation*; (*b*) Mere amplification of provisional; (*c*) Use to keep *constancy* implies use as *reservoir*; (*d*) Provisional use *was invention* as even the system of lighting (which is part of the combination) was new. It is, however, the combination which is relied upon.

4. This objection is based on theory that regulation is different from keeping constancy of pressure. No justification for this theory.

5. Contradicted by evidence. No evidence in support.

As to *Second Defendant's Cross Appeal*—1. Use of term *earth* in specification suggested to every electrician in 1878, the necessity for a suitable return, however obtained. This probably points to corrosion, and is a purely commercial question.

Earth used in description and figures in specification for sake of clearness and simplicity. Very difficult to draw fig 5 showing return by cable without using two colours. Earth is not an essential part of the invention (see Bramwell.) (*d*) Contradicted by all plaintiff's witnesses, and see books. (*e*) Even if *earth* is held to mean *soil* it would work in small installation. (See Hopkinson, questions 4,956 to 4,960.)

Subject Matter—General Note by Lane-Fox.—The idea of supplying electricity to incandescent lamps in parallel, as gas and water are supplied was *new* in 1878 (Perry 53 and 735—738; Lane-Fox 914—938; Barrett 3,225—3,236; Thompson 2,841—2,845). To carry out this idea it was necessary to have constancy of pressure (we use word *pressure*, not used before 1878, because the analogy with gas and water was not known), and everything described in specification is for this purpose. This is the *essence* of patent combined with the system, he therefore uses secondary batteries for *balancing* or *regulation*, and even now this is important. Nothing like the system of lighting itself, or the use of a reservoir for balancing or regulating in combination with such a system was known to Clark and Achard, or was anticipated by anybody (see Perry 39—41; Clark and Achard's reservoir, Perry 120, Lane-Fox's reservoir Perry 119; Perry 289—311, and all plaintiff's witnesses. See also Clark's specification, page 3 lines 16—21, also page 7 lines 5—10.

Answers to Defendants' Arguments.—(*a*) System of distribution, net work of mains at nearly constant pressure and high resistance lamps, *new*. (*b*) Admitted. (*c*) Combination quite new. (*d*) and (*e*) See Perry, questions 39 to 42. *Analogy*, air gun, old user, fire engine, air vessel, new user. (*f*) Incorrect. Included even in provisional by use of word *reservoir* and context. (Perry 91 and 98.) (*g*) Absolutely no evidence.

Infringement.—(*a*) Defendants use an equivalent return well known in 1878. (*b*) Contradicted by evidence. (See Bramwell, questions 4,486—4,491. See Hopkinson, question 5,297.)

1. Plaintiff intended to keep same pressure all over mains. (See Crompton, questions 7,224—7,226.) Feeder mains, a simple amplification or improvement of Lane-Fox system. This also applies to switches.

2. Contradicted by evidence. (See Crompton, question 7,392, Miller questions, 8,055 to 8,063.)

Lane-Fox's Patent.

JUDICIAL COMMITTEE OF THE PRIVY COUNCIL.

ON Thursday, 17th inst., Lord Watson, Lord Hobhouse, Sir Richard Crouch, and Lord Shand, had before them a petition for the prolongation of letters patent, dated October 9th, 1879, granted to Mr. St. George Lane-Fox for the invention of improvements in obtaining light by electricity, and in conveying, distributing, measuring, and regulating the electric current, and in the means or apparatus employed therein.

Mr. Lane-Fox (the petitioner) appeared in person. Mr. Roger Wallace and Mr. Shaw appeared for parties opposing the petition; Mr. Sutton represented the Crown.

Mr. LANE-FOX having stated the object of the petition, asked whether their Lordships would go into it, and entertain it, because the Court of Appeal might possibly decide that the patent was invalid.

LORD WATSON said the question for the Privy Council was not at all a question of the validity of the patent; they had to assume that the patent was valid when it came there, and the patentee who applied for a prolongation of his patent had to take the risk of it being upset. If the patent was upset, it became invalid, and the prolongation was of no use to anybody.

Their Lordships thereupon proceeded with the hearing.

Mr. LANE-FOX calling attention to the accounts.

LORD SHAND pointed out that in the accounts that had been submitted to them there were 8 years' accounts absolutely unaccounted for.

Mr. LANE-FOX said it was absolutely impossible for him to account for them, because the Brush Company had had his patent, and there were many other patents and things mixed up with it—it was practically impossible to dissever the accounts. He had assigned to the Brush Company, and if that company could be made to disclose the accounts, it might show something.

LORD WATSON said it was the duty of every patentee, who granted a licence of his patent, to insist on the licensee keeping strict accounts, and being able to show exactly what the working of the patent cost.

LORD HOBHOUSE said that before there could be a prolongation of a patent the Judicial Committee must report to Her Majesty that the patentee had not been absolutely remunerated. It was the rule that full accounts must be laid before the Attorney-General, and afterwards before the Privy Council, with a view of their being sifted so as to show the remuneration.

LORD SHAND repeated that there were 8 years working of the patent without a shadow of a return, and during that time there was no account of the profit (if any) that was made by the assignee of the patent.

Mr. LANE-FOX said the accounts in this respect were as full as possible.

LORD WATSON said it might be the petitioner's misfortune, but unless an account of everything paid or received on account of the patent was before them so as to furnish materials for a balance sheet, he could not succeed.

Mr. LANE-FOX, seeing the point their Lordships took, said he would not pursue it any further.

LORD HOBHOUSE, in giving judgment, said he was afraid the objection was quite a fatal one. There was no account of this original transaction that £5,000 passed, or of the previous license granted to the Brush Electric Company, or of the working of the patent in the hands of the Brush Company, or of the subsequent sum of £2,000 raised by mortgage, which the petitioner said in his petition he was liable to pay, but which it appears the new company, who were competitors with him, his assigners, were undertaking to pay.

LORD WATSON said there was another point on which information was given and which ought not to be lost sight of. In this case it appeared that a joint stock company, which must have been incorporated in terms of an Act of Parliament, because it was a limited company, carried on business for eight years. What the public paid in respect of that would all depend upon two things; first, upon the trade with regard to the patent, and in the second place upon their dealing with shares upon the Stock Exchange. That had been pointed out in more than one case as a matter very seriously affecting the question.

LORD HOBHOUSE: The petition will be dismissed.

Mr. ROGER WALLACE: My Lords, I only ask for one set of costs, although there are several petitioners.

LORD HOBHOUSE: You were served with a notice of this petition.

Mr. WALLACE: Yes; but it has been a great hardship. It has cost us several thousands of pounds, and I can only ask for one set of costs. All the petitioners have appeared by one counsel, consolidated so as to save expense.

LORD HOBHOUSE: The petition is dismissed with one set of costs.

LONDON CHAMBER OF COMMERCE.

ELECTRICAL TRADE SECTION.

MAJOR S. FLOOD PAGE presided at special meeting of the members of the electrical trade section of the London Chamber of Commerce, held at Botolph House, Eastcheap, on Friday last, when there were also present Mr. Henry D. Marshall, Mr. Binswanger, Mr. Sinclair, Mr. Emile Garcke, Mr. A. R. Bennett, Major C. E. Webber, Mr. R. S. Erskine, and Mr. W. H. Preece.

ELECTRIC TRACTION CASE.

The CHAIRMAN said he thought they would be interested in learning that since their last meeting the Special Electrical Traction Committee had made another step in advance, and a day had been arranged when they should meet the gentlemen of the opposite side on this question with the view really of ascertaining whether they could not save them spending £100,000 in litigation. He dared not say that they could do so, but they were hopeful, and had arranged for a meeting next week at which the National Telephone Company on the one side and the Leeds Tramways Company on the other, would be represented, and they were going to see whether it was possible to agree upon some *modus vivendi* so that both parties should have the use of the earth, or at least to see if something could not be done to avoid litigation. So far as they could see the litigation would be something very serious. They were told on the one hand that the Leeds case would settle nothing, and on the other hand that it would settle everything. But if they could by means of the Chamber of Commerce come to some arrangement between the two companies they would have done something for the benefit of the electrical industry. That meeting would take place next week, and he hoped that at the following meeting of the section he would be able to report on the subject. He then said that Mr. Preece was compelled to go to Wales that afternoon, and therefore to suit his convenience they would take, first, the subject of the Chicago Exhibition. A committee was appointed, and had had a meeting, and he (the speaker) need only say that the result of that meeting was that they had determined to call the present one, and asked Mr. Preece to attend so that the section might hear what he had to say as to their position and prospects in respect to the Exhibition.

ELECTRICAL PROSPECTS AT THE CHICAGO EXHIBITION.

Mr. PREECE then said that up to the present moment the prospect of the electrical section of the Chicago Exhibition being a successful one was rather remote. On the other hand most of the other departments were going to be a very big success. The industrial department, and what were called the liberal arts, were going to send from this country a most magnificent display, both in size and in the quality of the goods, ever sent to any exhibition. There would be more than 15,000 exhibitors, and the quantity of goods was so great that they had been obliged to reduce the space which had been allotted to others. As to the electrical section, out of 27,000 square feet allotted only 5,000 square feet had yet been taken. On that 5,000 square feet there would be some very good exhibitions. The following was the official list of exhibitors up to that moment :—

Name.	Address.	Description.	Space in square feet.
Electric Batteries, Primary and Secondary.			
Epstein Electric Accumulator Co., The, Limited.	West Kensington, W.	Secondary batteries.	210
Machines and Appliances for Producing Electrical Currents by Mechanical Power—Dynamical Electricity.			
Electric Construction Corporation, The, Limited.	Wolverhampton.	Dynamos and motors.	1,088
C. A. Parsons & Co. ...	Heaton Works, Newcastle-on-Tyne.	Dynamos and motors.	200
Transmission and Regulation of the Electrical Current.			
Ewing, Robert	Shaftesbury Avenue, W.C.	Conduits for electric cables.	25
Electric Motors.			
Ferranti, S. Z., de... ...	Charterhouse Square, E.C.	Alternating current motors.	450
Application of Electric Motors.			
Lorrain, J. G.	Strand, W.C.	Electric system of ventilation, clocks, &c.	110
Lighting by Electricity.			
General Electric Company, Limited.	71, Queen Victoria St., E.C.	Electric light fittings, lamps, &c.	400
Electro-Metallurgy and Electro-Chemistry.			
Elmore's American and Canadian Patent Copper Depositing Co., Limited.	64, Cannon Street, E.C.	Electro-deposited copper.	270
London Metallurgical Co., The, Limited.	80, Turnmill Street, E.C.	Arcas silver-plating.	1,600
Electric Telegraph and Electric Signals.			
Anders, G. L., and Kottgen.	10, Jeffrey's Square, E.C.	Telegraphs and electric signals, phonographs.	50
Phonopore Syndicate, The, Limited.	London Wall, E.C..	Phonopore telegraph apparatus.	196
The Telephone and its Appliances—Phonographs.			
Collier Audible Telephone Co.	Manchester.	Telephone receivers and transmitters.	100
Homacoustic Speaking Tube Co.	Telegraph St., E.C.	Voice tubes and communicators.	40

That, as he had said, was the official list of applications up to the present moment, but it did not at all adequately represent the British electrical industry. His chief object in attending that meeting was to see if he could not obtain their assistance, in order to secure something more like a typical display of the modes of fitting up houses and buildings generally with electrical apparatus. His opinion was that they might get together a kind of syndicate, who would fit up a *suite* of rooms, to have them furnished by English firms, as well as decorated by English decorators, and fitted up by the electric light engineers with their best and latest appliances, as now carried out in this country. In that direction they might be able to assist by forming a syndicate. For instance, if ten men would promise to subscribe, say, £250 each to meet the cost of exhibiting their own wares, the Royal Commission itself might come forward, and assist and take charge of the exhibits, and find some funds to aid in carrying out that object. Since they last met, they had received a circular from the department dealing with electricity at Chicago, asking English contractors to tender for the electrical lighting of portions of the building. Certain portions were set aside for European houses, and he believed that a copy of the circular which had been issued might be obtained from the Society of Arts.

Mr. E. GARCKE said they were all very much indebted to Mr. Preece for so kindly attending and giving them valuable information as to what was being done at the Chicago Exhibition, in the success of which they were all concerned. He was very much interested in

the success which had been attained in securing the adhesion of many English electrical firms, and he thought the suggestion which had been thrown out, with a view to a combination of all firms who had specialities, and who were likely to be well received in America, was a good one. He ventured to suggest, and he thought they might consider whether they might not ask the Chamber to issue a circular to the electrical trade, with a view to obtaining the general adoption of Mr. Preece's valuable suggestion. He (Mr. Garcke) thought there were a number of firms in the country to whom such a proposal would be acceptable. It was thought that there might be some little difficulty with regard to the firms sending out electrical engineers, because of the great trouble they now encountered in importing their manufactures into America. With regard to the firms which had been particularly mentioned, he thought that some such arrangement as had been suggested might afford the means of showing not merely what had been already done in this country, but the means of extending their business in the United States. He thought the figure which had been mentioned, as to the amount of subscription, was somewhat too high. If it were smaller it would be better, because the different firms would then be likely to respond to it, whereas he did not think they would look on the matter with favour if the amount remained so great.

Mr. BINSWANGER remarked that as to the question of their trade with America and the drafting of the circular, he thought it should be mentioned in the circular that the Chicago Exhibition was not likely to be of much use to them for their trade with the United States—it would rather be a meeting place for a great many foreigners, people from South America, Canada, China, and the East, and they would assemble there to see what had been done in the field of electrical science. From that point of view, the question would be of the utmost importance to English electrical manufacturers. Electrical engineering had passed the stage of mere experiment, and their manufacturing resources were very great. They were all looking to supply foreign markets, as were also other nations; and the race for those foreign markets would be extremely keen. The question, therefore, was one of very great importance. He was speaking from actual experience, for during the last two or three years he had established a certain connection and trade in the countries he had mentioned—in Canada, Mexico, China, and Japan—and he could inform the Chamber that he had received notice and intimation from almost every customer in those countries to the effect that they would visit the Chicago Exhibition, and would be pleased to see his, and other English goods, there. If, therefore, he were to abstain from exhibiting there, he would very likely lose whatever he had already—at the cost of great trouble and expense—gained. That seemed to him very important. He was sure English manufacturers could show to the world articles which would compare favourably with those of any other nation. It was to the efforts of scientific men, and fire insurance companies' inspectors, and consulting engineers, and to the immense capital which was invested in this country in electrical enterprise, that they owed their electrical industry, and it was by those means that that industry had been established on more sure, sound, and independent bases than in any other country. The general industry would be much helped by a comprehensive display of electrical goods in America. His firm had decided to exhibit there as well as they could; but he believed it would not do them much good to exhibit individually. It would be well for them, and for other individual firms exhibiting, if they showed their goods comprehensively, and acted together as one section, because it was well known that where a man placed his engine or dynamo, there he would very likely exhibit his wires, lamps, and other things; and it was for that reason he hoped they would be able to get a comprehensive electrical section together at Chicago.

The CHAIRMAN said he would like to ask Mr. Preece one question. The Chamber at one time ascertained that English exhibitors could not put English prices on their goods as well as the prices at which they would be able and willing to sell them in America. And afterwards the Chamber were directly informed that English exhibitors might show the English prices and also of the prices at which they could sell in America. But the rumour had reached them that, as a matter of fact, that permission had been counter-ordered. He would like to learn whether Mr. Preece could tell them definitely anything on the subject.

Mr. PREECE, in reply, stated that the executive of the Chicago Exhibition had distinctly conceded what had been stated, viz., they agreed to permit English exhibitors to display both English and American prices on their goods. But some doubt had since then arisen on the subject, in consequence of which Sir Henry Wood had gone out to America to ascertain whether the rumours they had heard were or were not true. On the very day that Sir Henry went out, a telegram was received in this country to the effect that the rumours were the result of a mistake, that everything had been arranged most satisfactorily, and that goods could be exhibited bearing both American and English prices whenever the exhibitors wished it.

Mr. ERSKINE thought the work of fitting up a room at the Exhibition, as suggested by Mr. Preece, ought not to be a matter of very great expense. He was also of opinion that the big English firms of furniture makers, decorators, &c., would be only too glad to join in the movement.

Mr. PREECE: My proposal was that the furniture manufacturers should go to the Exhibition as exhibitors.

Mr. MURRAY (the Secretary) stated, in reference to the last-named proposal, that he had been for some time endeavouring to work in the direction suggested. He had been urging upon the wholesale manufacturers of furniture to exhibit; but thus far he had not succeeded in moving them. However, it was quite possible, if the suggestion of Mr. Preece came to anything, that they might qualify their decision, and might, in connection with the electrical exhibits, be prepared to go into the scheme and show their furniture and other goods. If that chamber decided on anything definite, however, he should be glad to approach the furniture makers again on the subject.

Mr. MARSHALL thought it ought to be known to the section that some of the engineering firms of England had determined to keep away from the Chicago Exhibition altogether. It had been unanimously decided by them that it would not be an advantage to them, but, on the contrary, a thorough disadvantage, if they were to exhibit. This applied to the whole of the large engine makers. In consequence of the very prohibitive duties imposed by the Americans, the manufacturers felt that they could not, with any advantage to themselves, send their goods to the Exhibition.

The CHAIRMAN thought they might very well carry out the suggestion as to the circular, and if, as Mr. Murray had said, they could get a textile or the furniture manufacturers to send out a similar document to the members of their trade, should anything come out of it there might be a general meeting. If they thought that a practical suggestion, Mr. Garcke and himself would draw up a circular of the kind described. It was only right to point out, however, that some companies were rather in a difficulty. The companies who really supplied American patents in this country could hardly exhibit at the Chicago Exhibition. They were doing American business, and were not permitted to sell even a lamp. They never dreamed of sending anything to any country where their patent existed.

The Chamber then agreed to the proposed issue of a circular.

THE COUNTY COUNCIL AND OVERHEAD WIRES.

The CHAIRMAN then said that what he was about to state was practically of the nature of a report of the committee appointed at the annual meeting to deal with the very difficult question of the London County Council rules for the regulation of overhead wires. The committee had had the advantage of hearing the whole of the National Telephone Company, of the New Telephone Company, and of the Exchange Telephone Company, in fact, of all those interested in overhead wires, apart from electric lighting. When they entered upon their task they felt that the rules in question were most restrictive to trade, and that they would be most seriously detrimental to the electrical industry. They felt that to such an extent that, after several meetings, they prepared a petition to the Board of Trade; and when he told the meeting that the number of bye-laws were twenty-two, and that they objected to all of them but five, they would see that they traversed them pretty completely. The officials of the Chamber of Commerce pushed the petition though under great pressure extremely well, and the council could not but give them their full support. The result was that the petition went in. There was a meeting of the officials of the Board of Trade and the London County Council, the National Telephone Company, and the New Telephone Company were represented, as well as all those directly interested in the trade. The result was that certain concessions were granted, but those concessions did not go far enough; and with all possible courtesy the President of the Board of Trade, even after the inquiry had been held, allowed the Chamber of Commerce to appear before him. Sir Vincent H. Barrington introduced them, on behalf of the Council, and, although necessarily but a very small deputation, they received a hearing, and he thought he might say that the result had been to show the willingness of the Board of Trade to listen to any sensible suggestions or information from the Chamber of Commerce. He would give one instance of the sort of alterations they had obtained. With regard to the question of a fortnight's notice of carrying wires, he could say that that was impossible; but instead of giving fourteen days' notice before they ran a wire, it had—thanks to the good sense of the Board of Trade—been arranged that they were to give notice within one month after the wire was put up. If they could convince the Board of Trade officials that anything was restrictive to trade, they were quite willing to alter it. There was a great difficulty with the local authorities, because they were powerful bodies, and therefore they—the electrical industry—were between two stools, as it were: they had the pressure of the Board of Trade on the one side, and that of the local authorities on the other; but when they could show the Board of Trade that the trade was restricted by the rules, the Board would, he thought, give their support to the trade. Another rule which was not a very wise one on the part of the County Council, was the rule which restricted them in the matter of the length of span. It had been agreed that the companies could not have a greater span than 115 yards, and the London County Council had prohibited themselves from giving permission to the companies for more than 140 yards; but that restriction had now been taken away. Another really absurd rule was that although the companies had now sometimes 70, and even up to 140, wires on one pole, they were to be restricted to 20 wires on one pole. That had been done away with also. All that work was in connection with the question of the responsibility for the safety of the wires—a matter of great importance, no doubt. The telephone industry was rapidly becoming of great, and even national, importance. When they bore in mind that during the past year 160,000,000 of telephonic messages were sent in this country, at a cost of a little more than a halfpenny per message, while there were sent only 66,000,000 telegraphic messages, at a cost of about 7½d. each, they would not be surprised that the Postmaster-General had concluded that his telegraphic business was being interfered with by the telephone companies. The Board of Trade, taking the view they did, had met them on every point but one; and therefore he wanted to urge the meeting to authorise their committee to do even something more. It was still insisted that the owners of wires should be compelled to give information to local authorities or to the council, by themselves, or agents, or servants, at reasonable times, to go on other persons' premises to examine the wires and poles, when they had received permission for way-leave. He told Mr. Courtenay Boyle that, in the view of the section, that was the most restrictive

to trade. The difficulties in the way of getting way-leaves were immense. They could not go underground, and therefore they were compelled to remain overhead at present, and if they were to get way-leaves weighted by these extreme difficulties, it would, of course, be very restrictive to trade. Whilst they fully recognised the courtesy of the Board of Trade, he hoped the meeting would authorise the committee to take such steps as they might see fit, with the object of putting a little more pressure on the Board of Trade on the point of permission as to way-leaves. The only reason for the bye-laws objected to was that of public safety. If they were aware of the fact stated before a Parliamentary Committee two years ago, that out of 700,000 accidents, only two could be traced to the wires, then under no regulations, they must perceive that with regard to public safety there could be no necessity for such rules, or for supporting those who thought so much of the theory that an "Englishman's house is his castle."

Mr. BENNETT considered they ought to thank the committee for what they had done. He thought that the telephone companies were now contented with the bye-laws, with the exceptions referred to. With the knowledge that he possessed of the telephone business, he was sure that that bye-law would prove an insuperable obstacle to the business. It was very difficult indeed to obtain way-leaves, and it was often quite impossible to overcome the scruples of men and women they had to deal with; but if the modifications they asked for were obtained, their difficulties would be greatly reduced.

Major WEBBER was of opinion that there ought to be very little difficulty in introducing into the way-leave agreement a clause which would permit an official of the local authority, in the interest of public and private safety, to inspect the attachment, accompanied by an officer of the company. With such a clause, worded carefully, he did not consider that way-leaves could very well be refused. As to the way-leaves already obtained, the question was much more difficult. In such cases the local authority were bound to show how the leave to inspect was to be obtained.

Mr. GARCKE believed the clause could be made to appear in the interest of the householder. If that were done, it would render the matter much easier.

The meeting then agreed to give the committee the authority asked for, and after some conversation,

The CHAIRMAN suggested that it would be advisable, perhaps, to adjourn until October, unless something special made it necessary to meet earlier.

This suggestion was acquiesced in, and the meeting terminated.

NEW PATENTS—1892.

11,941. "Improvements in electricity meters." H. W. MILLER. Dated June 27th. (*Complete.*)

11,948. "Improvements in electric fire-alarm and circuit-controlling thermostat and clock mechanism." H. CORTLAND. Dated June 27th. (*Complete.*)

11,952. "Improvements in electric meters." J. W. JONES. Dated June 27th.

11,969. "Telegraphic (including telephonic) communication between light-ships and the shore." J. H. HIRST. Dated June 28th.

11,999. "Improvements in machines for making strands or cords and cables." W. H. H. SISUM. Dated June 28th. (*Complete.*)

12,039. "Improvements in the construction of electric railways and appliances therefor." T. FLOYD. Dated June 28th.

12,040. "Improvements in and connected with arc electric lamps." J. E. A. GWYNNE. Dated June 28th.

12,044. "Automatic supply of electricity." G. H. JONES. Dated June 28th.

12,057. "Improvements in printing telegraphs." S. R. LINVILLE. Dated June 28th. (*Complete.*)

12,087. "Improvements in electric heating devices and contacts for the same." F. W. SCHINDLER-JENNY. Dated June 29th.

12,122. "Improvements in microphone-mechanism." C. A. McEVOY. Dated June 29th.

12,191. "Improvements in electric railways." B. J. B. MILLS. (Communicated by E. H. Johnson, United States.) Dated June 30th. (*Complete.*)

12,212. "Electric regulating apparatus." J. M. BRADFORD. Dated July 1st.

12,238. "Improvements in and apparatus for producing and utilising electric currents." B. SCHEITHAUER. Dated July 1st. (*Complete.*)

12,246. "Improvements in electrical meters." Y. A. M. P. GOUBAUX. Dated July 1st.

12,258. "Improved electric glow lamp." P. SCHARF. Dated July 1st.

12,294. "Improvements in the manufacture of chlorine." H. W. WALLIS. Dated July 2nd.

12,295. "Improvements in electric arc lamps." W. HABGOOD. Dated July 2nd.

12,306. "Improvements in the construction of secondary batteries for electrical storage purposes." J. B. LEE. Dated July 2nd. (*Complete.*)

12,311. "Improvements in electric theft-prevention alarms." C. DARRAH and T. J. GOUGH. Dated July 2nd.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

The Price of all Specifications (old and new) is now 8d. each.

587. "Improvements in or connected with incandescent electric lamps." F. H. P. BERLYN. Dated January 12th. The inventor applies to the bulbs a case or cover which while sufficiently transparent to permit the required amount of light to pass through, is also of such colour, material and configuration as to prevent a dazzling effect. 2 claims.

1,905. "An improved method of and means for distributing electric currents." L. B. ATKINSON. Dated February 2nd. Consists in the combination with the main conductor, which may or may not be protected by fuses or cut-outs in the usual manner, of a subsidiary circuit insulated except at its extremities, from the main conductor, the subsidiary circuit being protected by a fuse or cut-out operating with less than the normal current carried by the main conductor. 6 claims.

6,773. "Improvements in apparatus for signalling time and for regulating clocks by electricity." L. VON ORTH. Dated April 20th. Claim:—For simultaneously regulating a number of secondary electric clocks that are connected by means of the wires of an electric system as for example of a telephonic system, with a central station at which the main or controlling clock is located, the described arrangement according to which at the central station there is included in the earth circuit common to all the branch circuits, a resistance coil, and the main clock together with a contact device and a battery are included in a shunt circuit thereto, so that whilst avoiding interruption of the wires of the said system when the contact device is closed, part of the current flowing through the said contact device will be sent into all the branch circuits, as set forth.

12,799. "Improvements in and relating to system of electric distribution." M. FEILBOGEN. Dated July 28th. Has for its objects to provide for interrupting the current of a constant electric generator or dynamo, so as to give the proper impulses to an inductorium, or series of such devices, to generate a secondary current, or a series of secondary currents to be employed in an electric light or working circuit, or a series of such circuits. 4 claims.

13,503. "Improvements in electric machines and apparatuses for differential phase alternating currents." M. VON DOLIVO-DOBROWOLSKY, electrician, and the company "ALLGEMEINE ELECTRICITATS-GESELLSCHAFT," both of Berlin. Dated August 10th. Is designed to reduce the number of line wires required in the system of connections of electric devices (such as coils and lamps) for generating and receiving differential phase alternating currents described in the specifications of the United States patents No. 390,414 to Tesla and No. 390,439 to Bradley. 1 claim.

13,553. "Improvements in electrically heated ovens." W. MITCHELL. Dated August 11th. The inventor constructs the bottom, top, and sides of the oven, or some if not all, of these with successive layers of asbestos or other insulating material, the heating wires being wound around the interior space of said oven in successive coils or layers which are interposed between said layers and practically embedded therein. 5 claims.

14,388. "Improvements in and relating to electric motors." G. C. DYMOND. (A communication from abroad by L. Gutmann, of America). Dated August 25th. Relates to a means and method of producing rotation of one coil relatively to another coil placed within inductive relation to the same and connected in circuit with an alternating, pulsating or intermittent current generator, by successively short-circuiting more or less of the sub-coils of the first coil. 10 claims.

14,663. "Improvements in couplings for connecting electric wires." A. SHIELS. Dated August 31st. The coupling consists of two parts, each with, preferably, a long and short projection, properly cut or recessed so as to clamp or lock into one another when brought together. The electric wires are led down or through each part and terminate in contacts which are, preferably, arc shaped and one above the other. The terminals or contacts, one positive and one negative, are inserted in a plug or piston of vulcanite or other suitable insulating material, fitted in each part at, preferably, right angles to its length. Surrounding the plug is a band or washer of rubber or equivalent material to keep out moisture. The terminals are tapered away, wedge shape, so that when the parts are locked together, they jam themselves tight. 3 claims.

14,764. "Improvements in armatures for dynamo-electric generators and electric motors." W. P. THOMPSON. (A communication from abroad by J. F. McLaughlin, of America.) Dated September 1st. Has for its object to produce an electric motor or generator, the armature coils of which are each separately wound, without requiring the handling of the armature as a whole; and these coils are so assembled and connected as to make it possible to remove any one of these coils, for inspection or repair, without dismantling the whole armature. It is consequently possible to replace defective coil by another new coil, thus facilitating and cheapening the repair of armatures. An additional feature of the invention is that the armature coils are on all sides protected against mechanical injury, being embedded in the armature body near the circumference thereof, and so close to that circumference that the inductive influence of the field magnets is exerted upon the coils to the best advantage. 8 claims.

15,575. "Improvements in galvanic batteries." A. DE MERITENS. Dated September 14th. This invention relates to the construction of powerful galvanic batteries with elements in which the hydrogen is mechanically eliminated and polarisation is practically obviated by employing as the positive pole of the element a couple composed

of two bodies of any description, provided that they are not attackable or liable to be affected by acids to the same degree. 9 claims.

15,597. "An improved galvanic battery." C. U. FISHER. (Communicated from abroad by R. H. Thompson, of New York). Dated September 15th. Claims:—1. A primary battery, the negative element of which consists of fibrous carbon made from rattan, substantially as described. 2. In a primary battery the negative element consisting of fibrous carbon connected to the line through a granular carbon conductor, substantially as described. 3. In a primary battery the combination with a granular carbon top plate, of fibrous carbon rods in intimate electrical union therewith, substantially as described. 4. In a primary battery the combination with a granular carbon top plate provided with a groove, of fibrous carbon rods held in said groove in intimate electrical contact with said top plate, substantially as described.

15,621. "Improvements in the method of making the plates or elements of a secondary or storage battery." S. C. C. CURRIE. Dated September 15th. Consists of an efficient and expeditious method of subjecting cast or rolled lead enveloped or encased in woven or braided fibrous material, in a suitable solution, to electrolytic action to cause a partial penetration and conversion of the same to a salt state and the reduction of the enveloped or encased partially penetrated and converted lead to a spongy or porous metallic condition without affecting the internal metallic body thereof, which forms the conducting part or portion of the plate or element, when mounted in battery. 5 claims.

15,645. "Improvements in and relating to ceiling blocks or roses and cut-outs for use in connection with electric light and other circuits." E. T. GREENFIELD and C. J. KINTNER. Dated September 15th. The first part of the invention relates particularly to improvements in switch or ceiling blocks which are used in the art for connecting electric lights and kindred translating devices to branch mains running into buildings and similar places. The second part relates particularly to switch devices for use in connection with electric light and analogous electric circuits, and is designed to take the place of the ordinary well known form of key switch, such as is found in general use in connection with incandescent electric lamps. 19 claims.

16,099. "Method of and apparatus for converting the electrical energy of alternating currents into mechanical motion." C. S. BRADLEY, R. S. TAYLOR, and R. T. MCDONALD. Dated September 22nd. In this invention a motor may be connected directly to a pair of alternating current terminals, the voltage of such currents being preferably reduced to a convenient and safe tension in the circuit in which the motor is placed. 12 claims.

16,522. "Improvements in or relating to electrically soldering or brazing metal." W. P. THOMPSON. (A communication from abroad by C. L. Coffin, of America. Dated September 29th. Claim:—The described process of soldering or brazing, consisting in connecting one or both of the articles to be soldered or brazed with one pole of a generator, connecting the tool to the other pole of the generator, bringing the tool in contact with the solder and seam to be soldered or brazed, and passing an electric current through the tool and material, while the tool is maintained in contact with the solder and seam, substantially as set forth.

16,526. "Improvements in pencils or electrodes for electric arc lamps." H. H. LAKE. (Communicated from abroad by E. Tweedy, of America.) Dated September 29th. Consists in associating with a suitable form of metallic rod, tube or holder, any substance into the composition of which chromium enters, either chemically or mechanically. 4 claims.

16,530. "Improvements in and relating to receiving instruments or relays for submarine cable and other electric circuits." H. H. LAKE. (Communicated from abroad by C. G. Burke, of New York.) Dated September 29th. Consists essentially of two coils of fine wire which are secured together at practically right angles and supported so as to turn in a magnetic field about a vertical axis. The magnetic field in which these coils are supported is produced by four poles, preferably those of two permanent magnets, placed with like poles opposite to each other. 11 claims.

17,003. "Machines for making grids for secondary batteries." A. F. MADDEN. Dated October 6th. Has for its objects, first, to utilise in the formation of the grid the pasty lead which collects in the melting-pot and is called "putty" lead, and which has been heretofore considered as highly objectionable and a hindrance to the process of casting; second, to force the lead into the form by a rolling process as contradistinguished from simple casting; third, to provide means novel in construction and method of operation for the heating of the lead and the maintenance thereof at the proper working temperature; fourth, to provide a novel construction of form in which the grid is shaped; and, fifth, and in general, to provide a machine which shall be simple in construction and easy of operation. 15 claims.

CORRESPONDENCE.

Electrocution.

I am reading in your 1st July impression an admirable article on electrocution, entitled "More Sentimentalism." I am now engaged in writing for *La Revue Encyclopedique* an essay, where I am trying to dispel the false notion spread on the occasion of Kemmler's execution by the *New York Herald's* Parisian edition. This paper having published a cracking article, false from "top to toe" on this subject, it has been reprinted all over the land and has created a *philo-guillotine* strong opinion, against which I am just now striving to advocate the cause of reason, justice, and true humanity. Certainly I will take advantage of your leader and quote it in my forthcoming publication. But, as a fellow worker in the same line and waging war against the same absurd prejudices, I should beg your assistance.

His Excellency, the Governor of New York State, kindly sent me the report drawn by Dr. MacDonald on Kemmler's execution, and some other official papers, which have been most serviceable, and which are at your command in case you need them for silencing your own "friends of the gibbet." I have been told that this able practitioner has published through the New York Academy of Medicine, a report on the seven first electrical executions which were presided over by him. I have written to several friends in the States in order to procure this important document, but they have returned no answer as yet. Would you obligingly direct me how to procure this as speedily as possible? My essay being just now in the hands of the publisher, I am afraid I shall not be able to stop the printing for a long period, and I should be most pleased to take advantage of Mr. MacDonald's work. The talent exhibited in the examination of Kemmler's case is a strong indication of the value of the more extensive contribution just issued. The difficulty of resisting cant, red-tapeism, stolidity, and routine, is such that I trust you will kindly excuse the trouble and send me the required information at your earliest convenience.

W. de Fonvielle.

Paris, July 1st, 1892.

P.S.—I was hoping to find some reliable intelligence in the London *Lancet*, but to my great surprise I found that this world-known and approved paper had published, relating to electrocution, the most miserable and revolting leader.

Friction Gear for Electric Motors.

In your last issue you referred to a letter which I wrote on June 3rd last to the *Engineer*, in which I advocated the use of friction gear for electric motors for tramcar work, in order to do away with the necessity for employing resistance coils at starting. There are one or two points in your remarks which I think are not clear. You say that less power is not consumed by the device I recommend than in resistance coils, merely contradicting my statement without quoting instances in support of your contention.

You next state that, "as a matter of fact, the power required to start any tramcar in a *given time* at a *stated velocity* is a definite *quantity*, and practically independent of the method of supplying power to the rolling axle." (The italics are your own.)

I quite admit that the power required is a definite quantity, if you mean by the word *definite* only *certain*; but if, as would appear, you mean to imply that it is a *constant* quantity, then I do not admit the truth of the statement at all. The actual power required depends upon the state of the rails, humidity of the air, direction and force of the wind, lubrication, &c., and may of course vary greatly in different tests. Again, lower down you use the expression, "definite torque," and to this the same remarks apply.

You say whether energy be wasted in heating the friction clutch or resistance is immaterial, this is, of course, only true if you first beg the question and take it for granted that the same amount of energy is wasted in the two cases; but this I do not admit. Resistance frames you say are cheap; whether you mean low in first cost, or efficient, I do not know, but no doubt they might fulfil both requirements if they could be used at the same time as cooking apparatus, or to warm water for heating purposes. These methods I did not consider quite feasible in tramcar work.

I believe you will find that my opinion will be supported by other electricians, and I am satisfied that if the losses in resistance coils could be made visible, as, for instance, they are in some cases on a small scale, where glow lamps are used instead of metal, that attention would be drawn to the immense waste now going on in electric tramcar work.

E. R. Dolby.

July 12*th*, 1892.